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THESIS

AN ANALYSIS OF RISK MANAGEMENT METHODOLOGY EMPLOYED WITHIN THE ADVANCED AMPHIBIOUS ASSAULT VEHICLE ACQUISITION PROGRAM

by

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March, 1995

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ABSTRACT

Risks are inherent in the development and acquisition of new weapon systems whose performance requirements surpass those of currently fielded systems. If not anticipated and managed "up front and early" in the acquisition cycle, these risks can have profound effects on a program's cost and schedule and, ultimately, on the combat effectiveness of the Armed Forces. Current Office of Management and Budget (OMB) and Department of Defense (DoD) acquisition policy requires the Program Manager (PM) to develop and tailor an acquisition strategy for each new program. The strategy must include methods for assessing and managing contractor and Government risks. For the U.S. Marine Corps' Advanced Amphibious Assault Vehicle (AAAV) acquisition program, development of a risk management methodology is the responsibility of the Direct Reporting Program Manager (DRPM/AAAV). Accordingly, this thesis investigates the risk management methodology employed within the AAAV program, illustrates how this methodology converges with and diverges from risk management methodology prescribed by and/or suggested by the "Body of Knowledge" (BOK) relating to risk management, and analyzes the applicability of the "Spiral Model". This thesis concludes by recommending areas where the BOK and the DRPM's methodology can be enhanced and suggests areas warranting further research.

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I. INTRODUCTION

A. BACKGROUND

The National Security Act of 1947 charges the United States Marine Corps to "develop those phases of amphibious operations which pertain to the tactics, techniques, and equipment employed by landing forces." With these words the United States Congress codified the amphibious role of the Marine Corps. Marines throughout history have been called upon to provide the essential elements of mobility, expeditionary capability, and forward presence to our national security posture. One key ingredient to the Marine Corps' success in this endeavor has been the development of the amphibious tractor and its successors, most often referred to as the "amtrac".

The amtrac has taken many forms since its introduction into the Marine Corps' inventory over 57 years ago. As technology and firepower have improved, so has the amtrac. This refinement continues today as the Marine Corps' Advanced Amphibious Assault Vehicle (AAAV) Program makes its way through the Department of Defense (DoD) acquisition process. The AAAV acquisition program will provide a replacement system for the current Assault Amphibious Vehicle (AAV7A1) which was fielded in 1972, underwent a major Service Life Extension Program (SLEP) in 1983-1986, and will be over 30 years old when the new AAAV family of vehicles is fielded.

As demonstrated in previous amtrac acquisitions, the engineering design and development of the proposed amtrac version will incorporate more advanced and complex technologies to meet evolving security conditions and new tactical requirements. This direction reveals the basic tenet of U.S national defense technology and industrial base policy to rely on technological innovation to modernize its forces and maximize combat power. [Ref. 1:p. 122]

The demise of the Soviet threat and the rise of the "new world order" has precipitated and will continue to precipitate the realignment of defense resources to meet other foreign and domestic requirements. Predictably, the increased technical complexity of today's weapon systems and dwindling defense dollars coupled with the alteration of operational roles and missions in the Armed Services intensifies the element of uncertainty and "risk" within all DoD weapon system acquisition programs.

As in any other major weapon system acquisition, success of the AAAV acquisition program is dependent on how well risk is assessed and managed. According to the General Accounting Office (GAO), greater attentiveness to risk assessment and risk management on the part of DoD Program Managers (PMs) is necessary [Ref. 2:p. 5]. DoD Directives require PMs to establish and maintain risk management programs to both assess and mitigate risk. Program Managers develop and tailor their risk management methodology based upon their individual interpretation and understanding of risk management concepts and requirements contained in the risk management "Body of Knowledge" (BOK). The BOK refers to current Office of Management and Budget (OMB) and DoD policies, directives, instructions, and guidance and includes reference materials derived from academic sources pertaining to the subject area of risk management. Examples of these sources include the Defense Systems Management College (DSMC) and the Project Management Institute (PMI).

The focus of this thesis is to examine the risk management BOK and risk management methodology in the AAAV acquisition program. For the AAAV acquisition program, development and implementation of a risk management program is the responsibility of the Direct Reporting Program Manager (DRPM/AAAV).

B. OBJECTIVES OF RESEARCH

The six objectives of this thesis are:

1. To examine risk management methodology delineated in the risk management BOK.

2. To analyze the DRPM/AAAV risk management methodology.

3. To conduct a comparative analysis of risk management methodology delineated in the risk management BOK with methodology employed by the DRPM.

4. To isolate areas where the DRPM's risk management methodology diverges from the risk management BOK and suggest improvements to the DRPM's methodology.

5. To identify attributes and features of the DRPM's risk management methodology which would enhance and contribute to the risk management BOK.

6. To assess the applicability of the "Spiral Model of Software Development & Enhancement" to the AAAV program.

C. RESEARCH QUESTIONS

The following primary research question addresses the six aforementioned objectives: <u>Can risk management and mitigation methodology implemented within the AAAV acquisition program contribute to the overall risk management "Body of Knowledge"?</u>

The following four subsidiary research questions support the primary research question:

1. What risk management and mitigation policies, guidance, strategies, and techniques are delineated in the risk management BOK?

2. What risk management and mitigation strategies and techniques have been employed by the DRPM/AAAV to address the principal risk areas identified in the AAAV program?

3. How does the DRPM's risk management strategy differ from the strategy delineated in the risk management BOK?

4. How can the "Spiral Model" be applied to the AAAV acquisition program?

D. RESEARCH METHODOLOGY

Data and information contained in this thesis were collected from the following sources: 1) interviews between the author and acquisition professionals involved with the AAAV acquisition program and Marine Corps acquisition programs; 2) review of applicable systems acquisition and program management literature and documentation providing current policies and regulations; and 3) review of unclassified documentation acquired from the DRPM/AAAV Program Office. Major sources of literary materials utilized for this thesis were the Naval Postgraduate School (NPS) Systems Management Department Acquisition Library, the NPS main library, and the Defense Systems Management College (DSMC).

Data introduced and discussed in Chapters II and III, and analyzed in Chapter IV of this thesis were presented utilizing computer generated spreadsheets (see Appendices C and D) coupled with standard narrative text. The style of computer spreadsheet developed is the Data Source Matrix (DSM). The DSM format enables the efficient cross-referencing of a data source to its attributes. By ordering and categorizing data furnished in the matrices the matrices are tailored to facilitate subsequent analysis of inherently qualitative data.

The general methodology used in Chapters II, III, and IV to organize, examine, and analyze both the risk management BOK literature and the AAAV program documentation (data sources) encompassed the following eight step process:

1. Selection of a representative sample of systems acquisition and program management literature for evaluation as the risk management BOK in Chapter II, Literature Review.

2. Selection of a representative sample of AAAV program specific management documentation and other related materials for evaluation in Chapter III, The Advanced Amphibious Assault Vehicle Program.

3. Examination of each literature item (data source) to ascertain its respective risk attributes.

4. Organization of risk attributes derived from each data source into functional risk attribute categories.

5. Assignment of a risk content indicator code for each risk attribute profiled within a data source.

6. Development of DSMs (Appendices C and D) to physically present the risk management attributes conveyed by BOK and AAAV program data sources.

7. Summary of significant trends, anomalies and other observations detected during the BOK and AAAV program literature review.

8. Accomplishment of a comparative analysis of the risk management BOK attributes with the AAAV acquisition program risk management attributes.

A more detailed explanation of the research and analytical methodology employed is presented in Sections C, D, and E of Chapter II, and in Sections H, I, and J of Chapter III.

E. SCOPE & LIMITATIONS

The scope of this thesis was to ascertain and analyze the management strategies and techniques developed to assess technical, supportability, cost, and schedule risks within the AAAV acquisition program. This study compared and contrasted the DRPM's risk management and mitigation methods with methods prescribed by or suggested in the risk management BOK.

It is important to recognize that the risk management BOK sampled is not inclusive of the total population of data sources existing which pertain to systems acquisition and program management. The BOK sample selected does, however, represent a balance of Government and non-Government views and adequately portrays risk management approaches provided in the risk management BOK and presently practiced "in the field".

The author also acknowledges that the AAAV program documentation and other related materials sampled and examined is not inclusive of the total population of data sources existing which pertain to risk management in the AAAV program. The sample selected represents a balance of Government and non-Government views and adequately portrays risk management approaches applied, on-going, and planned in the AAAV program.

This thesis incorporated opinions and comments of Government and defense industry officials to make inferences pertaining to the effectiveness of prime contractor and program manager's risk management plans. This thesis did not address insurance risk, safety risk, environmental risk, or accidental risk. These subjects are outside the DoD system acquisition and program management discipline and were likewise outside the scope of this study.

F. ASSUMPTIONS

It is assumed readers of this thesis: 1) have an understanding of the basic principles and current DoD policies governing systems acquisition and program management; 2) possess a comprehension of the basic concepts associated with the discipline of risk management; and 3) are familiar with basic amphibious warfare concepts and doctrine.

G. TERMINOLOGY

Acronyms and abbreviations utilized in this thesis, and their meanings, are furnished alphabetically in the List of Abbreviations and Acronyms, Appendix A. To alleviate confusion, terms not commonly known are explained in the Glossary of Terms, Appendix B. Whenever possible terms are defined according to DoD standard terminology.

H. ORGANIZATION OF THIS STUDY

This thesis is structured into five chapters. Chapter I, Introduction, identified thesis objectives, primary and subsidiary research questions, and provides remarks concerning the scope, limitations, and assumptions framing the study. Chapter II, Literature Review, presents a survey of the BOK relating to the subject of risk management. The policies, guidance, strategies, and techniques derived from DoD directives, as well as related literature from academia is categorized and examined. Chapter III, The Advanced Amphibious Assault Vehicle Program, identifies risk management and mitigation methodologies applied to the principal areas of technical, supportability, cost, and schedule risk identified in the AAAV program. In Chapter IV, Comparison of Risk Management Methodologies, a comparative analysis between the risk management methodology employed by the DRPM/AAAV and the methodology suggested and/or prescribed within the BOK is presented. The significant areas of convergence and divergence between the two domains are noted and emphasized. Additionally, an analysis of the Spiral Model is delivered. Chapter V, Conclusions and Recommendations, furnishes concluding comments and recommendations drawn from the research and proposes areas warranting future research.

II. LITERATURE REVIEW

A. INTRODUCTION

This chapter presents a survey of the BOK relating to the subject of risk management. Risk management concepts, policy, guidance, strategies, and techniques derived from DoD generated literature, from literature published by organizations external to the DoD, and from academia is categorized and examined.

B. BACKGROUND

Risk management in DoD weapon systems procurement has long been practiced by acquisition professionals. Even before it was formalized in policy, most PMs practiced risk management in some form. The recurring interest in this subject by policy makers is clearly visible through recent history. In 1969, Deputy Secretary of Defense Packard wrote a memorandum to the Military Services that identified inadequate risk assessment as a major problem area. In 1981, Deputy Secretary of Defense Carlucci published a memorandum which included 32 "initiatives" aimed at improving the acquisition process. Initiative 11 required DoD action to increase the visibility of technical risk in budgets of weapon systems acquisition programs. Then in 1986 the GAO cited inadequate technical risk assessment as a problem area within the Military Services in a report released to the chairman of the Committee on Government Affairs, U.S. Senate. The need for more effective risk management will be felt even more strongly in the future as we face more challenging technical problems coupled with declining DoD budgets. As policy makers' interest in risk management continues to grow, PMs should anticipate greater emphasis from senior management in this area. [Ref. 3:p. 2]

Office of Management and Budget (OMB) and DoD acquisition policy require weapon system PMs to develop and tailor an acquisition strategy for each new program. The strategy must include a process and plan and contain specific methods for evaluating and mitigating contractor and Government risks within the program. It is important to note that current policies do not require the risk management plan to be contained in a single document. Rather, the risk management plan is an integral part of the other written plans which are submitted during the planning and execution of the project [Ref. 3:p. 3]. This characteristic is a logical manifestation of the broader treatment of risk management as an integral part of the overall program planning and management process in a PM office.

Program Managers faced with the task of initially developing or revising their risk management plans should consult all applicable systems acquisition and program management literature and documents which provide policy, regulation, and guidance. The breadth of this literature is extensive and includes, but is not limited to, the following categories: 1) previously mentioned memorandums, reports and initiatives; 2) OMB Circular A-109 Major Systems Acquisitions; 3) DoD Directives and Instructions; 4) Service specific regulations; and 5) Military Standards (MIL-STDs).

Supplementing Federal policy documents and Service department directives are literature resources available from academia and from private sector institutions. Major literature resources available to the PM from this latter category include, but are not limited to, the current family of technical guidebooks published by the DSMC and the series of management handbooks published by the PMI.

In the aggregate, the segment of program management literature which pertains directly to the discipline of risk management composes the risk management BOK. The military acquisition professional preparing to undertake a risk management program should consider the examination of the risk management BOK as an essential ingredient in the initial formulation or subsequent improvement of the risk management plan.

C. METHODOLOGY FOR CONDUCTING LITERATURE REVIEW

The general methodology used in reviewing and documenting the evaluation of the risk management BOK encompassed the following six step process:

1. Selection of a representative sample of military systems acquisition and program management literature materials (data sources) for subsequent analysis as the risk management BOK.

2. Examination of each literature item (data source) to ascertain its respective risk attributes.

3. Organization of risk attributes derived from each data source into functional risk attribute categories.

4. Assignment of a risk content indicator code for each risk attribute profiled within a data source.

5. Development of a DSM, Appendix C.

6. Summary of significant trends, anomalies and other observations detected during the literature review.

It is important to recognize that the risk management BOK sampled is not inclusive of the total population of data sources existing which pertain to systems acquisition and program management. The BOK sample selected does, however, represent a balance of Government and non-Government views and adequately portrays risk management approaches provided in the risk management BOK and presently practiced "in the field". Sections D and E of this chapter provide a more detailed explanation of each step in the general methodology outlined above.

D. BODY OF KNOWLEDGE EXAMINED

Current editions of the following 23 literature items were sampled from the risk management BOK for examination in this chapter. Information obtained from these data sources will be used for a comparative analysis performed in Chapter IV, Analysis of Risk Management Methodologies:

1. Office of Management and Budget, OMB Circular A-109 Major Systems Acquisition, Washington, D.C., April, 1976.

2. Department of Defense, DoD Directive 5000.1 Defense Acquisition, Under Secretary of Defense (Acquisition), February, 1991.

3. Department of Defense, DoD Instruction 5000.2 Defense Acquisition Management Policies and Procedures, Under Secretary of Defense (Acquisition), February, 1991.

4. Department of Defense, DoD Manual 5000.2-M Defense Acquisition Management Documentation and Reports, Under Secretary of Defense (Acquisition), February, 1991.

5. Department of Defense, Military Standard-499B Systems Engineering, May 6, 1992.

6. Department of Defense, Risk Management Concepts & Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.

7. Department of Defense, Program Manager's Notebook, Defense Systems Management College, Ft. Belvoir, VA., June, 1992.

8. Department of Defense, Systems Engineering Management Guide, Defense Systems Management College, Ft. Belvoir, VA., January, 1990.

9. Department of Defense, Test and Evaluation Management Guide, Defense Systems Management College, Ft. Belvoir, VA., August, 1993.

10. Department of Defense, Integrated Logistics Support Guide, Defense Systems Management College, Ft. Belvoir, VA., May, 1986.

11. Department of Defense, Defense Manufacturing Management Guide, Defense Systems Management College, Ft. Belvoir, VA., April, 1989.

12. Department of Defense, Competitive Production Handbook, Defense Systems Management College, Ft. Belvoir, VA., August, 1984.

13. Department of Defense, Sub-Contracting Management Handbook, Defense Systems Management College, Ft. Belvoir, VA., May, 1988.

14. Department of Defense, Technology Transfer Guide, Defense Systems Management College, Ft. Belvoir, VA., November, 1988.

15. Department of Defense, Warranty Guidebook, Defense Systems Management College, Ft. Belvoir, VA., October, 1992.

16. Department of Defense, Mission Critical Computer Resources Management, Defense Systems Management College, Ft. Belvoir, VA., undated.

17. Department of Navy, Best Practices: How to Avoid Surprises in the World's Most Complicated Technical Process, NAVSO P-6071, March, 1986.

18. Department of Navy, Cost Realism Handbook, Navy Office for Acquisition Research, Washington, D.C., May, 1985.

19. U.S. General Accounting Office, "Technical Risk Assessment-The Status of Current DoD Efforts", GAO/PEMB-86-5, Washington, D.C., April, 1986.

20. Harp, D.M., A Management Case Analysis of the DoD Contractor Risk Assessment Program, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December, 1990.

21. Yosua, D.A., "Risk Management in Military Acquisition Projects", Military Project Management Handbook, Mc Graw-Hill, Inc., 1992.

22. "Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.

23. Boehm, B.W., "A Spiral Model of Software Development and Enhancement", Software Management, IEEE Computer Society Press, CA., 1993.

The above listed literature items represent the sample of thesis research data sources utilized. These data sources are portrayed in the same numerical sequence along the top horizontal margin of the risk management BOK DSM, Appendix C.

E. PRESENTATION OF DATA COLLECTED

1. Taxonomy of Data

The product of the literature review process is represented in the risk management BOK DSM, Appendix C. The DSM profiles risk management attributes directly extracted from the 23 data sources. These risk management attributes are portrayed along the left vertical margin of the matrix and are assembled into 20 distinct topical sub-categories. These attribute sub-categories, as listed below, correspond with and reflect risk management subject areas contained in the 23 literature data sources sampled:

1. Risk Definitions
2. Risk Management Concepts
3. Risk Management Planning
4. Risk Identification
5. Risk Assessment
6. Risk Analysis
7. Risk Documentation
8. Risk Mitigation
9. Risk Areas
10. Acquisition Strategy Concerns
11. Development and Design Concerns
12. Software Considerations
13. Prototyping and Technology Demonstration

14. Testing Considerations

15. Manufacturing Considerations

16. Contracting Considerations

17. Schedule Considerations

18. Cost and Budgeting Considerations

19. Logistics Considerations

20. Warranty Considerations

The process of conducting the literature review included the task of qualifying each risk attribute. The objective of the attribute qualification process was to ascertain and distinguish the relative functional purposes of each risk attribute. In general, attribute functional purposes ranged from attributes which are optional (requiring no active or explicit response and existing to serve a purely informational purpose) to the obligatory, compulsory or "must do" tasks.

A result of the attribute qualification process was the assignment of an appropriate risk content qualification code to each risk attribute profiled in the DSM. For simplicity, assignment of the risk content indicator code was dictated by its inherent functional purpose and was limited to one indicator code per risk attribute. The following legend defines the risk content indicator coding scheme utilized:

1. "M" coded attributes denote a risk concept, task or process element which is mandatory for the PM organization to accomplish, incorporate or adopt.

2. "R" coded attributes denote a risk concept, task or process element which is recommended or suggested for consideration, incorporation or adoption.

3. "S" coded attributes denote a risk concept, task or process element specified, described or defined in an informational context.

4. "I" coded attributes denote a risk concept, task or process element which is implied or inferred by a data source.

5. A "Blank" denotes no explicit nor implicit risk attribute coverage.

2. Synopsis of Research Findings

The following summary statements provide an overview of the significant patterns, anomalies, and other observations detected during the literature review process as evidenced by the risk management BOK DSM, Appendix C. To facilitate cross-referencing of the matrix to a summary statement, the literature data source(s) and attribute sub-category from which a summary statement was derived are identified within or following the text of each statement:

- A lack of uniformity and consistency exists in definitions of risk terminology and concepts provided in literature sources reviewed. Additionally, only one of the 23 data sources examined explicitly recommends that the PM establish a dictionary of risk terms and concepts. The lack of consistency in the BOK in defining risk concepts and terminology may create difficulties for the PM attempting to isolate the specific processes and measures to identify, assess, quantify, analyze, control, mitigate, and document risk within a particular program. Standardized risk management terminology would reduce opportunities for miscommunication. (Reference Attribute Sub-Category-Risk Documentation, Data Source 6).

- DSMC published literature (Reference Attribute Sub-Category- Risk Management Concepts, Data Sources 6-8) and non-DoD published literature (Reference Attribute Sub-Category- Risk Management Concepts, Data Sources 21-23) recommend or imply that the concept of risk management should not be treated as a separate function, but as an integral part of the overall planning activity in a PM office. These data sources simultaneously suggest that risk management needs to be made a more formal, systematic process rather than a subconscious activity. Some PMs and acquisition professionals may infer a disjunction between these two suggestions.

- Most BOK data sources mandate or recommend that the PM establish a risk management plan and institute measures to ensure the plan is assessed in conjunction with each milestone decision. Data sources, however, are neither consistent nor precise in detailing specific components to be incorporated in the risk management plan under development. This shortcoming could prompt a misallocation of a program's resources, ultimately impeding development of a PM's risk management plan. (Reference Attribute Sub-Category- Risk Management Planning, Data Sources 1-4, 6-11, 13, 17-19, 21, 23).

- BOK data sources reveal incompleteness in prescribing or recommending specific risk management actions to be taken during specific acquisition process phases. Only one data source (Reference Attribute Sub-Category- Risk Management Planning, Data Source 6) presents a basic framework of risk management actions recommended for implementation during specific acquisition phases. This shortcoming may also encourage misallocation of a program's resources, potentially impeding development of a PM's risk management plan.

- Minimal explicit reference to the potential for applying Total Quality Management (TQM) principles to the risk management discipline was evident in the data sources examined. All data sources do, however, implicitly illustrate or describe areas of opportunity within the risk management discipline where TQM principles could be applied. A commitment made by a PM to implement basic TQM principles, i.e., 1) to focus on the user; 2) to continuously improve processes; 3) to empower personnel, and 4) to eliminate non-value added activity, would complement a PM's risk management effort. (Reference Data Sources 1, 6-8, 10, 22, 23).

- Numerous occurrences of overlap and redundancy between and among risk attribute categories and data sources were detected. This idiosyncrasy is attributed to the previously mentioned pattern of definitional inconsistency coupled with the basic notion conveyed in the BOK that risk management is treated as a fully integral part of the overall planning activity in a PM office and not as a separate function. (For example; Reference Attribute Sub-Categories- Risk Management Concepts, Software Considerations, Data Sources 6-8, 16, 23).

- A majority of data sources convey the importance of the contractor's risk assessment and mitigation plan. (Reference Attribute Sub-Categories- Risk Assessment, Risk Mitigation, Risk Areas, Software Considerations, Testing Considerations, Contracting Considerations, Data Sources 1-3, 5-8, 10, 11, 13, 16-18, 20-23).

- Risk management attributes profiled in software (S/W) oriented data sources generally parallel and complement related attributes contained in most non-S/W data sources. (Reference Attribute Sub-Category- Software Considerations, Data Sources 16, 23).

- The role of a viable test and evaluation (T&E) program as an important component of the overall risk management planning is reiterated by a majority of data sources. (Reference Attribute Sub-Category- Testing Considerations, Data Sources 1-3, 7-11, 15, 21).

- Data sources provide superficial attention to the utility of the warranty as a viable component of a risk management plan. Only three data sources provide explicit reference to the warranty as a risk management component. (Reference Attribute Sub-Category- Warranty Considerations, Data Sources 8, 11, 14).

- Data sources provide superficial coverage to the utility of increasing Government attention to sub-contractor activities as a risk reduction method. (Reference Attribute Sub-Category- Contracting Considerations, Data Source 13).

F. SUMMARY

This chapter presented a survey of DoD and non-DoD generated literature relating to the subject of risk management. The product of the literature review process was represented in the risk management BOK DSM, Appendix C. Specific risk management concepts, policies, and guidance were categorized and profiled as risk attributes in this matrix. The matrix can assist any acquisition professional engaged in developing or revising a risk management program. In Chapter III, The Advanced Amphibious Assault Vehicle Program, the DSM technique is again applied to present and evaluate risk management methodology employed by the DRPM/AAAV.

III. THE ADVANCED AMPHIBIOUS ASSAULT VEHICLE PROGRAM

A. INTRODUCTION

The objective of this chapter is twofold. First, an explication of the AAAV program's historical development, current status and acquisition strategy will be presented. This background information is fundamental to the unification of the analytical framework of this thesis. Second, the risk management and mitigation strategies and techniques applied, on-going, and planned for the principal areas of technical, supportability, cost, and schedule risk identified in the AAAV program will be categorized and presented. The same research and analytical methodology used in Chapter II, Literature Review, including the DSM, will be employed in this chapter.

B. PROGRAM BACKGROUND & DESCRIPTION

A Mission Area Analysis (MAA) was initiated by the Marine Corps in 1987 to identify deficiencies in amphibious assault capability. The MAA determined that the AAV7A1 demonstrated significant deficiencies, during both water and land operations, in offensive and defensive firepower, water speed, land speed, agility and mobility, armor protection, and overall system survivability. These deficiencies prompted the Marine Corps to include the AAAV Mission Need Statement (MNS) addressing a replacement for the AAV7A1 in its Program Objective Memorandum (POM) 90-91 submission to the DoD.

Upon receipt of the MNS by DoD, a series of Milestone 0 (MS 0) program reviews were conducted by the Defense Resources Board (DRB) and the Defense Acquisition Board (DAB). The purpose of these reviews was to validate the Marine Corps' stated mission need and its implied request for initiation of a major system new start to rectify operational deficiencies. Favorable endorsements were received from both the DRB and DAB; however, the Marine Corps was directed to analyze a broader range of alternatives in addition to those already identified in the AAAV MNS.

Due to this expansion of scope, the Under Secretary of Defense for Acquisition (USD(A)) edited the original MNS and retitled the program the Advanced Assault Amphibian (AAA vice AAAV). A copy of this edited MNS was attached to both the MS 0 Acquisition Decision Memorandum (ADM) and Program Decision Memorandum (PDM) received in July and August 1988. Receipt of the ADM and PDM constituted transition to MS 0 and the commencement of the Concept Exploration/Definition (CE/D) phase of the AAA program. On 19 July 1993, the USD(A) changed the name back to the AAAV. [Ref. 5:p. 3]

The AAAV is an armored, tracked amphibious combat vehicle that carries a reinforced rifle squad and has a crew of three. The AAAV will allow the Navy and Marine Corps team to link maneuver in ships and maneuver ashore enabling Operational Maneuver From The Sea (OMFTS). OMFTS provides both ships and landing forces with sea space for maneuver, surprise, and protection. The AAAV will be the principal means of armor-protected land and water mobility and direct fire support for infantry during combat operations. It is an inherently multipurpose system ideally suited to overcome the challenges imposed upon Naval Expeditionary forces: the limitation of space aboard amphibious ships and the impediments to maneuver in the littorals. [Ref. 6:p. 1]

The AAAV family of vehicles will consist of a personnel variant (AAAV(P)) and a command and control variant (AAAV(C)). The AAAV program will provide a replacement system for the current AAV7A1 that was fielded in 1972 and underwent a major SLEP in 1983-86. The AAV7A1 will be over 30 years old and will have ended its useful service life when the AAAV is fielded. The AAAV will correct the existing deficiencies found in the AAV7A1.

C. PROGRAM STATUS & SCHEDULE

Although no formal exit criteria were published for the CE/D phase, guidance was issued in three areas in the PDM dated 14 July 1988, and the ADM dated 19 August 1988:

1. Examine all alternatives of placing infantry ashore, not just a new amphibious vehicle.

2. Explore standardization with the Army's Armored Family of Vehicles (AFV) program.

3. Revalidate the Landing Craft Air Cushion (LCAC) acquisition objective.

The number of alternatives identified in the MNS was increased from three to 13 candidate systems. These systems fell into four broad categories: 1) high-speed amphibians; 2) low-speed amphibians; 3) non-amphibians; and 4) non-vehicles. Of the 13 alternatives analyzed in the program's Cost and Operational Effectiveness Analysis (COEA) the Advanced Amphibious Assault Vehicle-Fast (AAAV-F) was determined by the Marine Corps to be the preferred alternative to meet the requirements of the replacement system to the AAV7A1. The operational necessity of this program is critical to the continuing combat effectiveness of United States' Naval expeditionary forces.

The AAAV program was directed to aggressively pursue technical risk-reducing activities by the Navy Acquisition Executive in 1991 during the CE/D phase. All significant technical risk-reducing projects for the AAAV have been completed, formally reviewed, and favorably endorsed by the Office of the Chief of Naval Research (CNR). [Ref. 6:pp. 1-2] A discussion of these risk-reducing activities is provided in Section K of this chapter.

Figure 1 contains the program master schedule from the Integrated Program Summary (IPS) depicting selected key major activities in relation to MS decision points, as well as the present Initial Operational Capability (IOC) and Full Operational Capability (FOC) dates. The Demonstration and Validation (D&V) phase contract is planned to be 49 months in length, during which time one AAAV prototype (personnel variant) will be fabricated and tested.

PROGRAM STRUCTURE - ADVANCED AMPHIBIOUS ASSAULT VEHICLE

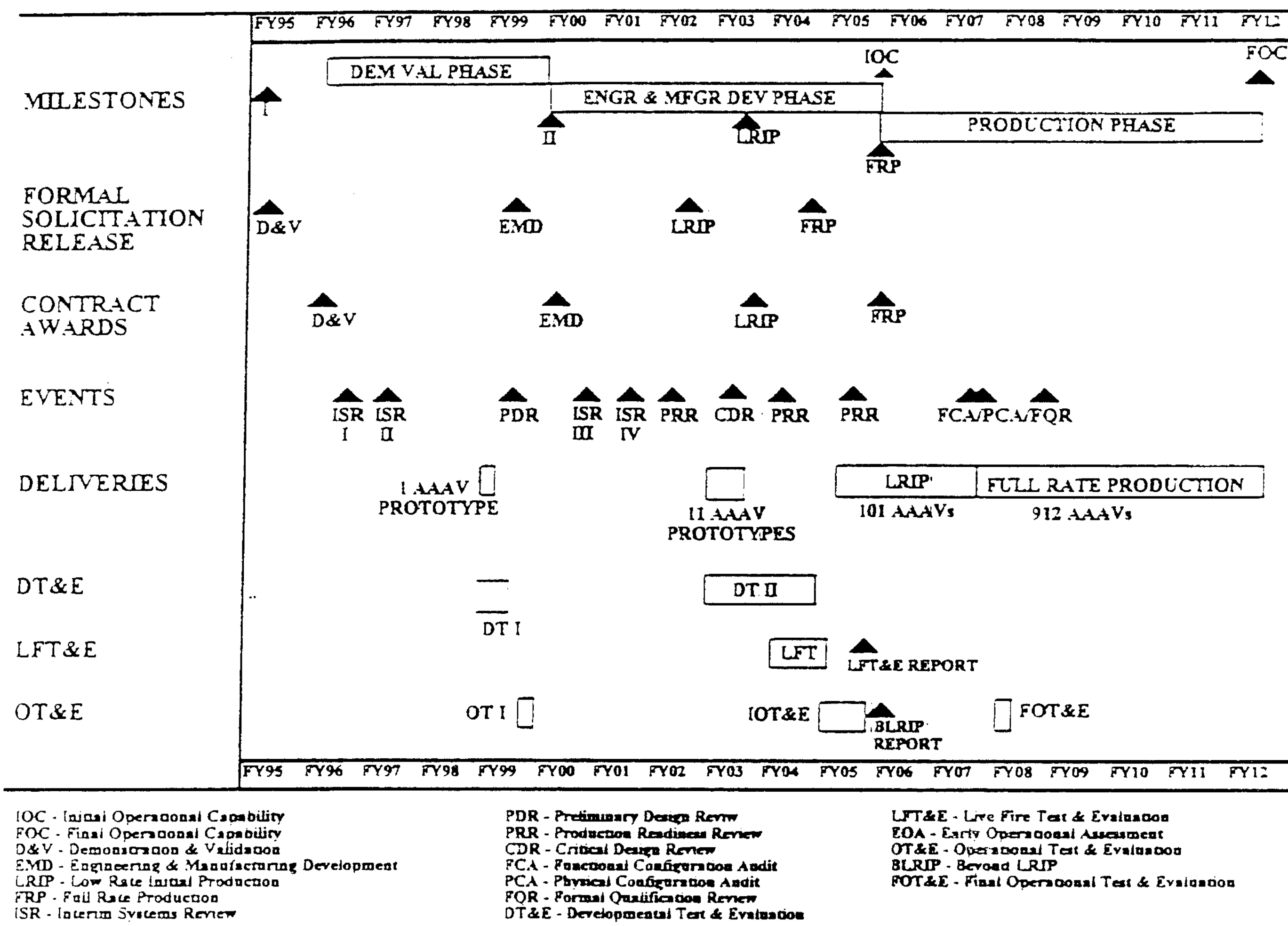

Figure 1. Program Structure for the AAAV Program

Primary engine 400 hour North Atlantic Treaty Organization (NATO) and 1000 hour durability tests will also be accomplished during this contract along with fabrication and testing of the AAAV(C) communications suite.
Developmental Test I (DT I), as well as an Early Operational Assessment (EOA) and Operational Test I (OT I) are scheduled for completion by FY 99.

Milestone II is presently scheduled for FY 00. The Engineering and Manufacturing Development (EMD) phase will be a total of 69 months from contract award, during which 11 prototypes will be fabricated and tested. Live Fire Test and Evaluation (LFT&E) will be conducted on two production representative prototypes prior to delivery of Low Rate Initial Production (LRIP) vehicles. A 48 month LRIP production contract will be awarded during the EMD phase for production of 101 AAAVs. Initial Operational Test and Evaluation (IOT&E) will utilize nine production representative prototypes, as well as four LRIP AAAVs. DT II is scheduled for FY 03-04 with a Full Rate Production (FRP) MS and IOC in FY 06. A 78 month FRP and Deployment phase will terminate in FY 12 with delivery of 1013 AAAVs. [Ref. 6: pp.2-3]

D. ACQUISITION STRATEGY

The baseline acquisition strategy for the AAAV includes D&V, EMD, and FRP phases. LRIP will be initiated near the end of EMD and will be immediately followed by the FRP phase. Figure 2, coupled with the information in the following subsections, furnish the detailed descriptions of each acquisition cycle phase. [Ref. 6:pp. C-2-C-4]

1. Demonstration & Validation Phase

One prime contractor is planned for the D&V phase. The D&V Request for Proposal (RFP) will be released promptly following MS I program approval. On receipt of contractor proposals, the Government will commence a formal source selection that will result in a single cost-reimbursement award-fee contract planned for award in the 1st Quarter (QTR), FY 96 for the conduct of the D&V phase effort. The primary focus of the D&V phase will be the maturation of the prime contractor's AAAV design, NATO and full durability testing of the AAAV engine, and the fabrication and testing of a AAAV(P) prototype and a AAAV(C) communications suite prototype. The prime contractor will be fully responsible for development of the preferred engine and the Government will pursue development of alternative engines.

2. Engineering & Manufacturing Development Phase

A cost-reimbursement EMD contract will be awarded to the D&V phase contractor during the 2nd QTR, FY 00. The primary focus of the EMD phase will be the completion of the contractor's AAAV design, fabrication, and testing of 11 EMD prototypes, and conduct of LRIP. Engineering and Manufacturing Development (EMD) will validate the AAAV configuration as a complete system from the standpoint of reliability, durability, availability, and supportability. Engineering and Manufacturing Development (EMD) will also finalize manufacturing technology and facilities readiness, and demonstrate the system's overall operational suitability for employment in combat operations.

3. Full Rate Production & Deployment Phase

The LRIP contract awarded during EMD will result in prime contractor production of AAAVs at an increasing rate through FY 05, 06, and 07. Following the FY 06 DAB FRP MS review, a fixed-price FRP contract will be awarded to the EMD/LRIP contractor for production of an additional 912 AAAVs. Deliveries of the FRP AAAVs will begin in FY 07 at a rate of 200 per year commencing 21 months after contract award and continuing at this rate through FY 11.

E. ACQUISITION APPROACH

The AAAV program is pursuing an acquisition approach to derive maximum benefit from previously developed combat vehicles such as the M1 Main Battle Tank (MBT), the Bradley Fighting Vehicle (BFV), and the predecessor to the AAAV, the AAV7A1. Numerous Non-Developmental Item (NDI) subsystems have been identified by the competing prime contractors (General Dynamics Land Systems (GDLS) and United Defense Limited Partnership (UDLP)) for use in their respective designs. The DRPM/AAAV is applying resources toward application and integration of existing armored vehicle technologies to its operational mission. The DRPM/AAAV has taken full advantage of lessons learned in the armored vehicle and amphibious vehicle technology base, ensuring GDLS and UDLP have had access to all available information.

Numerous amphibious vehicle technology demonstrators have been tested and the results promulgated. General Dynamics Land Systems and UDLP developed viable concept designs through use of extensive data from the amphibious vehicle technology base program. The contractors' development effort was supported by information derived from numerous technical activities funded under CE/D contracts. Both GDLS and UDLP are experienced combat vehicle developers and manufacturers.

Pre-Planned Product Improvements for the AAAV have not been developed nor validated at this time. However, the vehicle's design requirements include mandatory growth potential for weight, power, offensive weapons, and electronics. Recognizing the rapid acceleration in technology applicable to combat vehicle systems and to accommodate various propulsion alternatives, each prime contractor's AAAV is designed with an "Open Architecture" to accept installation of alternatives without incurring significant rearrangement of internal subsystems and components.

The D&V prime contractor will have total system responsibility as the AAAV integrator. No Government Furnished Material nor Equipment (GFM/GFE) is envisioned for the D&V or EMD phases other than weapons, ammunition, and communications equipment. Major subcontractors include manufacturers of the engine, the weapons sight and fire control, and the suspension system. These subcontractors and others will be examined by the DRPM/AAAV for potential breakout during the EMD phase. [Ref. 6:pp. C-6-C-7]

F. ACQUISITION STREAMLINING INITIATIVES

The AAAV program examined several acquisition streamlining initiatives and alternative program structures. Several have included the deletion or combination of acquisition phases. One significant streamlining initiative is the DRPM/AAAV request for an exception to the requirement for competitive prototyping (i.e., 10 U.S. Code, Section 2438, "Major Programs: Competitive Prototyping, "Subsections (a) and (b), per subsection (c), "Exception") during the D&V phase. Approval of this exception is projected to result in significant cost savings to the Government.

The competing prime contractors are performing multiple reviews of D&V specifications with the goal of complete removal of military specifications and standards. They have been specifically directed by the DRPM/AAAV in the D&V RFP to suggest commercial equivalent replacements for these specifications and standards. [Ref. 6:p. C-8] In addition, during D&V any surviving military specifications and standards cited in the RFP will be provided for guidance only and requirements will be stated in terms of performance vice design criteria. In an effort to commercialize and streamline future contracts to the maximum extent possible, the D&V contractor will draft the EMD, LRIP, and FRP contract Statements of Work (SOW) and specifications prior to final

Government editing. Maximum use of streamlining initiatives will continue to be pursued by the DRPM in this deliberate program structure. [Ref. 6:p. C-8]

G. COMPETITION & CONTRACT TYPES

Award of the D&V contract is expected to be made using Other Than Full and Open Competition. Authority for this is 10 U.S. Code, Section 2304, Subsections (c) and (1) as implemented in FAR 6.302-1, "only one source or a limited number of sources." Competition will be restricted to UDLP and GDLS, who are the only reasonable prospective sources due to their extensive work on the AAAV since 1990.

The D&V contract will require competition in subcontracting to the maximum extent practicable, by use of the "Competition in Subcontracting" clause, FAR 52.244-5. Competition will be sought, promoted, and sustained for subsystems, major components, spare parts, and services as the AAAV design is refined during D&V.

Most data will be delivered to the Government with limited rights. However, it is anticipated that some data may remain proprietary, either because of the use of commercial or NDI components or because of development of components using private or Independent Research and Development (IR&D) funds.

No detailed component breakout review has been performed as yet due to the development status of the program and the AAAV design. Once a D&V contractor is selected and its AAAV system design and subsystem selection is complete, a detailed component breakout review will be performed.

The D&V contract will be a Cost-Plus-Award-Fee (CPAF) type contract. The EMD contract will also be a cost-reimbursement type contract, most likely a Cost-Plus-Incentive-Fee (CPIF).

The LRIP contract (facilitization and first lot of vehicles) will be a cost-reimbursement contract.

The remaining lots of LRIP vehicles, covered by LRIP contract option, will most likely be fixed-price. The FRP contract will be Firm-Fixed-Price (FFP). [Ref. 6:pp. C-10-11]

H. METHODOLOGY FOR ANALYZING RISK MANAGEMENT PROGRAM

The general methodology used in reviewing and documenting the risk management and mitigation strategies and techniques applied, on-going, and planned for the principal areas of technical, supportability, cost, and schedule risk identified in the AAAV program encompassed the following six step process. This process is functionally equivalent to that employed in Chapter II, Literature Review:

1. Selection of a representative sample of AAAV program management documentation and other related materials (data sources) for subsequent analysis.

2. Examination of each data source to ascertain their respective risk attributes.

3. Organization of risk attributes derived from each data source into functional risk attribute categories.

4. Assignment of a risk content indicator code for each risk attribute profiled within a data source.

5. Development of a DSM, Appendix D.

6. Summary of significant trends, anomalies and other observations detected in the literature reviewed.

It is important to recognize that the AAAV program documentation and other related materials sampled is not inclusive of the total population of data sources existing which pertain to risk management in the AAAV program. The sample does, however, represent a balance of Government and non-Government views and adequately portrays risk management approaches applied, on-going, and planned in the AAAV program. Sections I, and J of this chapter provide a more detailed explanation of each step in the methodology outlined above.

I. PROGRAM DOCUMENTATION EXAMINED

Current editions of the following 17 AAAV program management documents and related literature items were sampled for examination in this chapter and will support the comparative analysis performed in Chapter IV, Comparison of Risk Management Methodologies:

1. U.S. Marine Corps, Operational Requirements Document (ORD) for the Advanced Amphibious Assault Vehicle (AAAV), C.G. MCCDC, Quantico, VA., March 24, 1994.

2. U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the Direct Reporting Program Manager, Arlington, VA., October, 1994.

3. U.S. Marine Corps, Test and Evaluation Master Plan for the Advanced Amphibious Assault Vehicle (AAAV) Program, Office of the Direct Reporting Program Manager, Arlington, VA., July 8, 1994.

4. U.S. Marine Corps, System/Segment Specification (Type "A" Spec.) for the Advanced Amphibious Assault Vehicle (AAAV) Program, Office of the Direct Reporting Program Manager, Arlington, VA., August, 1994.

5. U.S. Marine Corps, Human System Integration (HSI) Plan for the Advanced Amphibious Assault Vehicle (AAAV) Program, Office of the Direct Reporting Program Manager, Arlington, VA., March 8, 1994.

6. Department of Navy, Technical Assessment, Advanced Amphibious Assault Vehicle (AAAV) Updated Concepts, Office of Advanced Technology, Chief of Naval Research, Washington, D.C., November 15, 1992.

7. Center for Naval Analysis, Advanced Amphibious Assault (AAA) Program Cost and Operational Effectiveness Analysis (COEA): Ship-to-Shore Analysis, Alexandria, VA., July, 1990.

8. Center for Naval Analysis, Life Cycle Costs of Advanced Amphibious Assault System Candidates, Alexandria, VA., January, 1991.

9. Center for Naval Analysis, Revised Life Cycle Costs for Advanced Amphibious Assault System Candidates, Alexandria, VA., April, 1991.

10. U.S. Marine Corps, An Opportunity for Change: A Briefing for the Commandant of the Marine Corps, Office of the Direct Reporting Program Manager, Arlington, VA., June, 1993.

11. U.S. Marine Corps, "Commandant of the Marine Corps' AAA Article", AAV-AAA Requirements Office, MCCDC, Quantico, VA., September, 1993.

12. Department of Defense, Audit Report: Acquisition of Advanced Amphibious Assault Vehicles, Rpt.No. 93-116, DoD Inspector General, Washington, D.C., June 18, 1993.

13. Department of Defense, FY-94 Integrated Priority List (IPL) Administrative Guidelines, Defense Simulation and Modeling Office (DMSO), Washington, D.C., 1994.

14. Holzer, Robert., "Testing Simulation's Worth", Navy Times, January 24, 1994.

15. Robertson, B.J., "From Ship to Shore-And Well Beyond", Armed Forces Journal, September, 1994.

16. Corcoran, Michael. A., An Evaluation of Competitive Procurement Methodologies Applicable to the AAA Program, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December, 1988.

17. Clark, James. W., Acquisition Streamlining: A Viable Method for Accelerating Procurement of the AAAV, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December, 1993.

The above listed program management documents and related literature items are portrayed in the same numerical sequence along the top horizontal margin of the DSM for the AAAV Program, Appendix D.

J. PRESENTATION OF DATA COLLECTED

1. Taxonomy of Data

The product of the literature review is represented in the DSM for the AAAV Program, Appendix D. The matrix profiles risk management attributes extracted from the 17 data sources. Attributes are portrayed along the left vertical margin of the matrix and for simplicity are assembled into 17 distinct topical sub-categories. Sub-categories, as listed below, correspond with and reflect risk management topics contained in the 17 AAAV program management data sources sampled:

1. Risk Definitions
2. Risk Management Planning
3. Risk Assessment
4. Risk Analysis
5. Risk Documentation
6. Risk Mitigation
7. Risk Areas
8. Acquisition Strategy
9. Development and Design
10. Prototyping and Technology Demonstration
11. Testing
12. Modeling and Simulation
13. System Integration
14. Contract Management
15. Cost and Budgeting
16. Logistics Management
17. Software Design and Development

As in the risk management BOK literature review performed in Chapter II, Literature Review, the process of conducting the program management documentation and literature review for the AAAV program included the task of qualifying each risk attribute profiled in a data source.

The objective of the attribute qualification process was to ascertain and distinguish the relative functional purposes of each risk attribute profiled in a data source. In general, attribute functional purposes ranged from attributes which document a specific risk management strategy or technique previously applied within the AAAV program to attributes representing activities suggested by program proponents and oversight agencies.

A product of the attribute qualification process was the assignment of an appropriate risk content qualification code to each risk attribute profiled in the DSM, Appendix D. For simplicity, assignment of the risk content indicator code was dictated by its inherent functional purpose and was limited to one indicator code per risk attribute. The following legend defines the risk content indicator coding scheme utilized:

1. "A" coded attributes denote a risk management concept, task, strategy or technique which has been applied within the AAAV program.

2. "O" coded attributes denote a risk management concept, task, strategy or technique which is on-going within the AAAV program.

3. "P" coded attributes denote a risk management concept, task, strategy or technique which has been identified for future application within the AAAV program.

4. "R" coded attributes denote a risk management concept, task, strategy or technique which has been recommended for application within the AAAV program.

5. "*" coded attributes denote a risk management concept, task, strategy or technique which has been applied, is ongoing, and planned for continued application within the AAAV program.

6. "S" coded attributes denote a risk management concept, task, strategy, technique, or condition which has been specified as effecting the AAAV program.

7. A "Blank" denotes no explicit nor implicit risk attribute coverage.

2. Synopsis of Research Findings

The following summary statements provide an overview of the significant patterns, anomalies, and other observations detected during the program management documentation and literature review process as evidenced by the DSM, Appendix D. To facilitate cross-referencing of the matrix to a summary statement, the specific literature data source(s) and attribute sub-category from which a summary statement was derived are identified within or immediately following each summary statement:

- Most AAAV program data sources describe, in considerable detail, the overarching function and specific components of the Technology Base program associated with the AAAV development effort. The purpose of the Technology Base program was repeatedly featured as a key aspect of the DRPM's overall risk management, risk assessment, and risk mitigation efforts. (Reference Attribute Sub-Category- Risk Mitigation, Data Sources 2-4, 6, 10, 11, 15, 17).

- AAAV program data sources describe specific acquisition management activities to be taken during specific acquisition phases, as well as those activities planned in conjunction with subsequent MS decision reviews. (Reference Attribute Sub-Category- Acquisition Strategy, Data Sources 2-4, 16, 17).

- AAAV program data sources illustrate the direct association, linkage, and interdependence between the DRPM's evolutionary acquisition strategy (i.e., Paradigm Shift Model) and risk management and mitigation effort. (Reference Attribute Sub-Category- Acquisition Strategy, Data Sources 2-4, 10, 11, 16, 17).

- Most data sources explicitly show that proven Total Quality Management (TQM) principles: 1) user focus; 2) continuous process improvement and problem prevention; 3) innovation in processes, products, services; and 4) participatory management [Ref. 10:p. 13-3] are employed as components of the DRPM's risk management strategy. (Reference Attribute Sub-Categories- Acquisition Strategy, Risk Documentation, Risk Mitigation, Development and Design, Prototyping and Technology Demonstration, Testing, Logistics Management, Data Sources 2-5, 10-12, 15, 17).

- AAAV program attribute sub-categories evaluated in this Chapter and profiled in Appendix D are not identical to risk management BOK attribute sub-categories evaluated in Chapter II and profiled in Appendix C. A more detailed analysis of this anomaly is presented in Chapter IV, <u>Analysis of Risk Management Methodologies</u>.

- Several AAAV program data sources discuss and emphasize the role/importance in using prototypes and technology demonstrators in the acquisition process. (Reference Attribute Sub-Category- Prototyping and Technology Demonstration, Data Sources 2, 3, 6, 11, 16, 17).

- Several AAAV program data sources reveal that the DRPM's acquisition strategy incorporates the following risk mitigation elements: 1) development and employment of advanced technologies for each vehicle subsystem; 2) prudent application of Off-The-Shelf (OTS) and NDI components; 3) use of common subsystems and components in all AAAV mission role variants; and 4) transfer of current communications, electronics, and navigational equipment from the AAV7A1. (Reference Attribute Sub-Categories- Development and Design, Prototyping and Technology Demonstration, Logistics Management, Data Sources 1-5, 11).

- AAAV data sources neither explicitly nor implicitly acknowledge problems potentially emerging from or associated with the employment of an "evolutionary" acquisition strategy but supported by a "classical" test and evaluation (T&E) approach. The author views this subject as a thesis topic area warranting further research by NPS students. (Reference Attribute Sub-Categories- Acquisition Strategy, Testing, Data Sources 2-4, 10, 11, 17).

- Several data sources discuss the function/criticality of program "stakeholders" to the future of the program. (Reference Attribute Sub-Categories- Risk Mitigation, Acquisition Strategy, Development and Design, Logistics Management, Data Sources 2-6, 10, 11, 15, 17).

- Several AAAV program data sources examined discuss the function and criticality of both evaluating and applying, where appropriate, lessons learned from other acquisition programs, as well as sharing lessons learned with other programs. (Reference Attribute Sub-Categories- Risk Documentation, Development and Design, Testing, Modeling and Simulation, Contract Management, Logistics Management, Data Sources 1, 3, 12-14, 16).

- AAAV program data sources identify S/W as a critical AAAV subsystem prone to rapid evolution. Risk associated with S/W design and development was assessed as moderate by the DRPM/AAAV. Unlike other technical risk areas, AAAV program data sources did not, however, recommend nor identify an explicit, detailed strategy to mitigate this risk area. The author views this topic as a thesis subject area warranting further research by subsequent NPS students. (Reference Attribute Sub-Categories- Development and Design, Software Development and Design, Data Sources 1, 2, 4).

K. PRINCIPAL AREAS OF PROGRAM RISK

1. Overview

Following a program overview, this section summarizes the principal areas of technical, supportability, cost, and schedule risk existing in the AAAV program. Risk areas are expressed in terms of functional areas. For each risk functional area identified, a rating assessment (Low, Moderate, or High) and a discussion of risk management and mitigation strategies and techniques employed by the DRPM is provided. Information in this section was derived principally from the risk management DSM for the AAAV Program, Appendix D. The DRPM/AAAV Integrated Program Summary (IPS), and the Office of Advanced Technology (OAT) Technical Assessment for the AAAV (Matrix Data Sources 2 and 6) provided supplemental data required to develop the subsections which follow.

Definitions to ratings applied to each risk functional area are furnished in the Glossary of Terms, Appendix B.

Prior to MS 0, a Technology Base program was conducted to demonstrate the feasibility of subsystems and technology areas identified as critical to the success of a self-deploying high water speed (HWS) amphibious vehicle. The Technology Base program took a dual path for technology studies and experiments (land mobility, water mobility) and integrated these efforts into the successful fabrication and testing of two different size (scale) technology demonstrators.

During the land mobility portion of the Technology Base program, components and subsystems were fabricated and tested on fielded combat vehicles and on a 14 ton Automotive Test Rig (ATR). The ATR was a slow water speed (SWS) amphibious vehicle which integrated a "drive-by-wire" computer control system, lightweight track, retractable hydropneumatic suspension, and a remote controlled, unmanned weapon station.

The water mobility portion of the Technology Base program consisted of over 1,000 hours of hydrodynamic model tests to evaluate a variety of system concepts and configurations. Subsequent to this testing, a 0.5 scaled Hydrodynamic Test Rig (HTR) of a planing hull concept was fabricated and tested. The HTR confirmed it was possible to predict the hydrodynamic performance of a heavily loaded planing hull. The scaling procedures used in the 1/12, 1/8, and 1/6 scale tow basin models were validated by the 1/2 scale manned model.

The two parallel paths were integrated by modifying the ATR to incorporate the hydrodynamic appendages, large power plant, and newly developed water jets into a fully amphibious, track laying, 17 ton HWS Technology Demonstrator (HWSTD). The HWSTD validated performance predictions by exceeding 30 knots during over water testing. The next step was the design, fabrication and testing of a 29 ton, fully amphibious, track laying Propulsion Systems Demonstrator (PSD).

The PSD was fabricated using a composite hull and demonstrated established land and water mobility requirements.

To reduce risks associated with the utilization of lightweight composite materials for the armor on combat vehicles, two composite hull M-113 Armored Personnel Carrier (APC) vehicles were designed and fabricated. Both vehicles completed a 600 hour hull durability test program. One of these vehicles was selected to continue testing and subsequently completed a 2,000 hour (20 year equivalent) durability test without structural failure.

Since initiation of the CE/D phase, the AAAV program has focused efforts on identifying and reducing key risk drivers. After a competitive solicitation, conceptual design contracts were awarded to the GDLS and to the UDLP. During these conceptual study contracts, both contractors developed initial designs, conducted hydrodynamic model testing, developed and ballistically tested various armor schemes, and fabricated full-scale mockups of their respective concept. Upon conclusion of these contracts, several independent risk assessments were performed.

The first risk assessment was performed by the Office of Naval Research (ONR) using staff scientists and independent specialty area consultants. This effort was concluded in July 1991, and identified several continuing risk areas. One of these areas was the ability of available engine(s) to produce the required 2,600 horsepower for the AAAV application. This lead to an independent assessment conducted by Ricardo, Incorporated of available engine candidates. The result was the identification of an upgraded MTU 883 series diesel engine, a primary choice.

At the same time the Marine Corps Operational Test and Evaluation Agency (MCOTEA) conducted EOAs on both contractors full-scale mockups. Subsequent to these independent assessments, both contractors were awarded risk-reduction contracts to refine their concepts based on data collected. This included a requirement for an "open engine bay architecture" design to ensure their design approach was independent to the success of any single engine candidate.

Additionally, both contractors were permitted to pursue risk reducing projects of their own selection, coupled with a requirement to fabricate and test a large scale HTR. The HTRs were fabricated and testing was completed in 1993. Hydrodynamic Test Rigs varied in size from .75 to .80 scale. Both HTRs achieved water speed in excess of 30 knots, thus validating the technical feasibility of achieving the required water performance.

Additional contract activity included hydrodynamic model testing, appendage actuation experiments, and continued ballistic testing of armor. Both contractors updated their full-scale mockups to reflect changes to their designs, and MCOTEA conducted a second EOA with the results provided to both contractors. [Ref. 7:p. 66]

The ONR performed a second risk assessment in 1992, again using staff scientists and independent specialty area consultants. Their evaluation was concluded in November 1992, and determined that prior risk areas had been successfully addressed. ONR recommended that the AAAV program proceed into full-scale prototyping.

In September 1993 contracts were awarded to UDLP and GDLS for the design, fabrication, and testing of a full scale ATR. Both contractors initiated fabrication of their ATRs and testing began during 1st QTR FY 95. Computer modeling and simulation has shown that both designs will possess the land mobility characteristics to match or exceed those of the M1 MBT. [Ref 6. pp: D-3-4]

2. Technical Risks & Mitigation Strategy

This Subsection identifies the principal areas of technical risk existing in the AAAV program and explains the mitigation methodologies adopted by the DRPM/AAAV for each risk area.

- Hull- **Risk Assessment- Low to Moderate**- To reduce the risk associated with the development of the AAAV hull several actions have occurred. The Marine Corps has invested in technology development of lightweight armors, both composite and the more traditional metallic, to provide a solid base for hull development. Two full scale composite M-113 APC vehicles were built in 1985 and tested from 1985 to 1987. The Government PSD technology demonstrator used a composite hull, and the U.S. Army fabricated and tested a composite hull M-2 BFV for 6,000 miles. The DRPM/AAAV is maintaining contact with the Army's Composite Armored Vehicle program to ensure lessons learned are incorporated into the AAAV. Risk associated with the hull has been reduced as much as possible for this phase. Every aspect of hull performance is being analyzed and tested. Tests to date indicate required hull performance levels will be achieved. Failure during LFT&E is the primary schedule risk created by the hull. By investing in the Ballistic Hull and Turret (BH&T) planned for the D&V phase, this risk is reduced. The efforts associated with manufacturing complete hulls increase the knowledge of the producibility issues, thereby reducing cost risk.

- Suspension- **Risk Assessment- Low**- Both competing contractors' designs use experience gained from previous and current development programs within DoD and, where appropriate, utilize commonality of components within the DoD military vehicle inventory. Development of suspension systems for tracked vehicles is not a new technology for military vehicle applications. Both competing contractors have previously developed and fielded military vehicles with suspension systems. Both competing contractors were awarded contracts in FY 93 to design, build, and test their AAAV retractable suspension systems on a full scale ATR which represents their AAAV design. Government testing of ATRs will be conducted at the Aberdeen Proving Ground (APG) during the 2nd and 3rd QTRs of FY 95 to demonstrate that their systems are capable of operating with the M1 MBT. These tests will be completed prior to the start of the D&V phase. The ATR contract also requires that both contractors design, build, and test their AAAV track. The track is to be tested during the suspension system test. These efforts reduce the risk associated with the AAAV suspension system and AAAV track development prior to the D&V phase. Lessons learned from ATR contract efforts will be applied in development of the D&V prototype suspension system. Additionally, the winning D&V contractor will use its ATR for testing and data collection which will further contribute to the maintenance of the overall program schedule.

- Propulsion- **Risk Assessment- Moderate**- Competing D&V contractors are required to maintain "an open engine bay architecture" as a design requirement. This approach ensures more than one candidate engine can be installed in the AAAV without incurring costly rearrangement of the internal vehicle subsystems and components. Alternative candidates under consideration are a single diesel engine, a rotary engine, and a diesel/turbine engine combination. The competing contractors are required to have a margin on thrust and weight to further minimize impact on the engine selected. To assess the risk associated with the engine, the DRPM used various agencies to evaluate viable candidates. These include both AAAV competing contractors, Ricardo, Inc., Naval Surface Warfare Center (NSWC) Annapolis, and the CNR. As a result of these analyses, competing AAAV contractors have selected a hybrid of the MTU 883 engine as their primary engine candidate. The winning D&V contractor will be required to identify both a primary and secondary engine choice and will be responsible for the primary engine maturation and qualification. The qualification of the vehicle's primary engine prior to MS II has been established as a MS I exit criteria. The qualification test will consist of a 400 hour NATO test and a 1,000 hour endurance and certification test to ensure the engine is qualified for production prior to MS II.

- Automotive Drive Train- **Risk Assessment- Low**- The AAAV automotive drive train will use a NDI, production based transmission. Both competing contractors conducted studies of their proposed propulsion systems and concluded that an existing NDI, production based transmission satisfies their design requirements. Both competing D&V contractors are using their primary transmission choice in their respective ATRs. Given the testing of the ATRs at APG, each contractor will have an early indication as to whether its AAAV transmission performs adequately. Lessons learned from the transmission on the ATR will be applied to the development of the D&V prototype.

- Marine Drive Unit (MDU)- **Risk Assessment- Low**- Several tests and analyses have been conducted to lower risks associated with the MDU. Computer design and prediction techniques were developed at the NSWC-Carderock Division. These predictions have been validated by scale model testing. Large scale models of proposed MDU have been employed to propel both the Government's and contractors' HTRs in open ocean testing. This verification testing measured actual performance within three percent (3%) of modeling predictions. As this component involves the use of proven systems and known characteristics, it is assessed a low risk rating.

- Nuclear, Biological, Chemical (NBC)- **Risk Assessment- Low**- Protection for embarked Marines in an NBC contaminated environment is a core requirement of the AAAV. To meet this requirement, the AAAV will use an Advanced Filtration System (AFS) and an environmental control system. Technology for the AFS is being developed by the U.S. Army's Environmental Research, Development, and Engineering Command (ERDEC). Technology associated with the environmental control system is mature. Environmental Research, Development, and Engineering Command will install an AFS unit on the Government PSD to demonstrate system integration and environmental suitability. If ERDEC is unable to mature the AFS in time to field the AAAV, then an existing combat vehicle filtration system will be installed. The AAAV will maintain the capability to upgrade to an AFS.

- Weapon Station- **Risk Assessment- Low**- The AAAV Weapon Station is being developed from a long lineage of developmental and in-service designs. Due to the high rate of change in selected weapon station technologies, the system is being designed with attention to an open architecture. Using this approach, improvements may be incorporated into the turret as the system matures. Both competing contractors have performed conceptual design studies to examine several weapon station alternatives. The station will adapt components and subsystems developed for other combat vehicles. No new technology is being employed by the AAAV weapon station, therefore the risk is assessed as low by the DRPM.

- Communication/Navigation Equipment- **Risk Assessment- Low**- All radio systems and antennas used in the AAAV are currently employed by other fielded systems. All navigational, position location, and intercom systems in the AAAV will be in use during the timeframe.

- Software Development- **Risk Assessment- Moderate**- The AAAV is a system that intends to employ the maximum amount of established components and developed software from previously fielded systems. The risks associated with the AAAV S/W development focuses on four major areas: 1) **Requirements:** The DRPM conducted several technology demonstrations during the CE/D phase to prove technology and mitigate risks. Although S/W was not the primary issue involved during these activities, S/W was implemented and provided benefits by its application; 2) **Resource Constraints**: The DRPM/AAAV must manage risks associated with uncertainties in resource estimating and test and support equipment. By employing a sound design methodology such as the Object Oriented Approach (OOA), any S/W modification requirements will be more resilient to design changes; 3) **Development Approach:** The criticality and complexity of the AAAV S/W mandates selection of a sound development approach. The ATR effort explained previously in this section has provided the DRPM/AAAV insight into each of the competing contractors S/W design process; and 4) **Technology**: Technological assessments relating to techniques, tools, or equipment utilized for the S/W development have occurred with each of the technology demonstration efforts described previously in this section. Lessons learned from these efforts will be applied during the AAAV development.

- Land Mobility- **Risk Assessment- Low**- During the ATR contracts, both competing contractors used modeling and simulation programs to demonstrate that their AAAV can operate to requirement levels specified in the ORD [Ref. 8:p. 15]. Testing of the ATRs will be performed by the Government at the APG during 2nd and 3rd QTRs, FY 95 to demonstrate that each competing contractor's system is capable of operation with the M1 MBT, and to validate their modeling predictions. Accomplishment of these tests will be completed prior to the start of the D&V contract. Furthermore, the Government is conducting an independent modeling assessment using the NATO Reference Mobility Model. The purpose of this assessment is to confirm the contractors' prediction. Lessons learned from the ATRs will be applied in the development of the D&V prototype suspension system. Modeling and simulation will be updated accordingly.

The AAAV program intends to demonstrate land mobility requirements prior to the D&V contract award.

- <u>Water Mobility</u>- **Risk Assessment- Low to Moderate**- There is technical risk associated with integrating into a single AAAV, the three primary components (vehicle weight, available power, efficiency of transferring power into thrust) required to produce high water speed. To mitigate risk associated with water mobility, a variety of tests and analyses have been performed. Several small scale hydrodynamic tests have been performed. Two large scale technology demonstrators have been constructed and employed in the Marine Corps' Technology Base program. Each competing prime contractor constructed large scale HTRs to demonstrate the capability of its technical approach. The successful demonstration of the high water speed requirement by these technology demonstrators has significantly reduced the risk in this core area.

- <u>Weight Control</u>- **Risk Assessment- Moderate**- Weight control or weight growth has been an area of moderate risk for all combat systems during both development and production. The AAAV program has taken the following four actions to minimize risk in AAAV weight growth: 1) Independent weight growth assessments of each competing prime contractor's design to isolate and resolve differences between the independent weight estimate and the contractor's estimate; 2) Application of a five percent (5%) weight margin by each competing prime contractor on its AAAV design in an empty configuration to permit the factor of uncertainty in vehicle weight estimating; 3) Requirement for each competing prime contractor to establish a permanent weight control and reduction program; and 4) Requirement for each competing prime contractor to assign component and subsystem weight as a heavily weighted criterion during all trade-off analyses. [Ref. 7:pp. 17, 35]

- <u>Test and Evaluation (T&E)</u>- **Risk Assessment- Low to Moderate**-There is low to moderate risk associated with the AAAV program T&E effort. Adequate time is scheduled for the retest, redesign, and evaluation of all test results. The highest maintenance item for the AAAV is the suspension system, and the ATR is designed primarily as a suspension test bed. The ATR will operate during the D&V phase to acquire test data on suspension, final drive, hull form, stowed appendage robustness, and ride quality. The AAAV suspension system will incorporate selected NDI suspension subsystems and components. Integration of these components into the ATR and the continuous operation of the ATR during the D&V phase reduces schedule and technical performance risk of the D&V prototype. An HTR will also be operated as a test bed during the D&V phase. The HTR enables early comprehension of design changes in a field environment and reduces the impact of design modifications on the overall D&V schedule and prototype test phase. A BH&T will be delivered during the D&V phase. The testing of the BH&T provides a high level of confidence in the armor solution built for the D&V prototype. If deficiencies are discovered by this testing, sufficient time is available to alter the design and incorporate changes into the D&V prototype. Two production representative vehicles produced during EMD will be used for LFT&E. Two mockups (one non-functional and one functional) of the AAAV(C) will be constructed. The functional mockup is transportable and will be used in a mobile field environment to identify command and control problems. Additionally, the communication suite of the AAAV(C) will be installed in the ATR during D&V. These test articles allow for evaluation of the command and communication suite, human factors, systems integration, power requirements, potential interference between the electronic subsystems, and software issues. All previously discussed activities will be completed prior to integrating AAAV(C) hardware and software items into a AAAV prototype. The area where moderate risk exists in the D&V test schedule is the availability of a single prototype. The scope and depth of data collected during D&V could be limited by the presence of only one prototype. A catastrophic loss of the prototype could substantially and adversely impact on the program. While this is unlikely, it is an issue that increases risk in the T&E area.

- <u>Systems Integration</u>- **Risk Assessment- Moderate**- The final AAAV design will incorporate many technologies, systems, and subsystems required to meet littoral region land and water requirements as a total system. Many subsystems and components proposed by AAAV contractors in their conceptual designs exist and have been proven on other U.S. combat vehicle systems. Examining these subsystems and technologies independently, an assessment of "Low" risk may he obtained. However, regardless of the number of NDI subsystems and technologies in the AAAV, this will be the first time these items and technologies will have been integrated to perform together in this unique environment. Furthermore, certain systems integration factors, such as weight control, center of gravity control, interior space and volume control, exterior hull form design, hydrodynamics, and their interrelationships become critical to a vehicle design. To mitigate risk associated with AAAV systems integration, the Marine Corps required the contractors to weigh heavily the critical systems integration issues in every AAAV design and trade-off analysis performed during the concept phase and to continue to do so in the D&V phase. Additionally, specific system integration risk-reducing activities have been conducted. These activities include: 1) fabrication and Government user evaluation of full-scale AAAV mockups that included all major subsystems and their removal and maintenance paths; 2) use of sophisticated three dimensional solid models for analysis of systems integration, operability and maintainability; 3) fabrication and testing of near-full-scale amphibious vehicle technology demonstrators similar in design to contractor conceptual AAAV designs; 4) full-scale operational hydrodynamic appendage integration and testing for evaluation of hydrodynamic subsystem complexity; 5) S/W versus H/W trade-offs and resulting S/W rapid prototyping and testing; and 6) weight control programs and independent weight assessments of conceptual AAAV designs. [Ref. 6:p. D-15-16]

3. Supportability Risks & Mitigation Strategy

Supportability and Integrated Logistics Support (ILS) management is considered low risk because the program has been continuing to define and direct supportability risk reduction from the initial contractual efforts. Management effort is focused on ensuring design contractors comprehend the complexity of support in the intended operational environment. Using existing support methodologies, the DRPM directed early identification of high cost drivers and high maintenance items, and required the contractors to examine more cost effective alternatives for achieving the desired technical objectives. The following paragraphs identify the principal areas of supportability risk existing in the AAAV program and explain the mitigation actions taken to date by the DRPM/AAAV for each risk area:

- Life Cycle Support- The DRPM is addressing risks associated with life cycle support of the AAAV. Actions taken by the DRPM have identified the high Life Cycle Cost (LCC) drivers and investigated alternatives to achieving required support within budgetary constraints. The program's initial concern was the early identification of the high cost drivers. Normally, during the early stages of a program the focus is on achieving the system's technical performance requirements. To counterbalance this, the DRPM has required the competing contractors to use the Equipment Designers Cost Analysis System (EDCAS) during the AAAV design process. The Equipment Designers Cost Analysis System is a software model that permits isolation of high cost drivers concurrently in the engineering design process. Reliability and maintainability parameters were also input for each design into the EDCAS model. The contractors were required to address the data and results of the EDCAS analyses as part of their conceptual design reports. When Operations and Support (O&S) issues were not addressed in the decision process, the contractors were required to reassess their design using required parameters.

- Design Rules- The DRPM capitalized on lessons learned from other weapon system acquisition programs in the area of supportability. Understanding that the maintenance of complex weapon systems is a high cost driver, the DRPM identified ways to minimize the impact of the system on the overall Marine Corps maintenance structure. The Marine Corps developed Design Rules which have been provided to the design contractors. Design Rules focus on risk mitigation in terms of designing maintainability into the AAAV during early design stages. Competing contractors are required to use and report achievement of these design rules at the system, subsystem, and piece part levels. By requiring the designers to comply with these design rules or lessons learned, the DRPM will reduce the maintenance burden of the AAAV and reduce effect O&S costs. Presently, 26 design rules are in effect to reduce maintenance workload, personnel skill requirements, and limit the growth of special tools and test equipment.

- Partitioning- In conjunction with the Design Rules and EDCAS modeling, the DRPM also required the contractors to perform partitioning analyses on their designs. The focus of the partitioning analysis is to identify subsystems and components where lower costs during the O&S phase can be realized by reducing manpower, personnel and training, spare and repair parts, transportation costs, and test equipment. Partitioning also focuses on separating low-service life components into unique groupings to reduce maintenance times required for servicing.

- RAM-D- The DRPM structured a test schedule which uses a conservative vehicle hours per month requirement to ensure attainment of critical reliability testing. This conservative estimate of less than 24 vehicle hours per month ensures that AAAV prototypes will have the opportunity to achieve the hours required to support the AAAV Reliability Program. The suspension system has been identified as a potential RAM risk driver. Automotive Test Rigs are under construction by the competing contractors in an effort to design, build, and test their objective AAAV suspension system. This effort reduces RAM risk associated with the suspension system. Additionally, a Failure Mode Effects and Criticality Analysis (FMECA) on the ATRs has been required to identify early failures and their systemic impacts.

- Maintainability- To positively influence the life cycle support of the AAAV, contractors have been required to assess maintainability aspects of their designs. The Marine Corps conducted maintainability and diagnostics demonstrations on each conceptual design. These demonstrations were conducted as both computer simulations and physical demonstrations utilizing full-scale vehicle mockups.

- Human Systems Integration (HSI)- With the use of JACK Human Factors Modeling and Supercard Rapid Prototyping simulations, the location and types of controls and displays were developed. JACK Human Factors modeling combined with other simulation was utilized to evaluate driver visibility in land and water plane intercepts. The results were changes to the vehicle's hull configuration for improved visibility.

- Modeling and Simulation (M&S)- The objective for use of M&S is to accelerate development and reduce technical and cost risks. One specific goal is to reduce the number of prototypes while meeting all T&E requirements in the TEMP [Ref. 9]. To accomplish these goals, the AAAV M&S plan focuses on using emerging technologies in Distributed Interactive Simulation (DIS). By using common simulations, standard data bases, and reconfigurable technology common to other Services, the Marine Corps is ensuring compatibility with ongoing DoD efforts. The result is a M&S capability developed and validated by Joint Service efforts which can be applied early in the development phase of the AAAV design. The Marine Corps' ability to introduce design changes into a simulated environment enhances operational suitability of the end item, allows for user evaluation, and produces a more combat effective system with less risk. [Ref. 6:p. D-15]

4. Cost Risks & Mitigation Strategy

Based on the conservative choice of technologies, estimating techniques, and the nature of the items estimated, cost risk is viewed as low to moderate.

The present Life Cycle Cost Estimate (LCCE) was preceded by several cost estimating activities including estimates for material alternatives to the AAAV and estimates by the two competing prime contractors both for a "streamlined" AAAV program and the present baseline schedule.

The final LCCE reflects conservative technical choices. Where a question existed regarding technology to be incorporated into the AAAV, the LCCE includes the more expensive technology. For example, the LCCE included a composite hull, even though one of the competing contractors indicated it will use a less expensive aluminum hull. The following estimating techniques were used for the final LCCE:

- Actuals from the M1 MBT, BFV, PSD, and other similar development and production programs.
- Quotes and purchase histories for developed components or NDI components.
- Historical levels of effort in areas as Program Office operations and O&S costs.

Most elements of the LCCE reflect existing or developed technologies (e.g., Communication and Navigation equipment). Elements including developmental items (e.g., engine) were conservatively estimated. A risk analysis was included in the LCCE. The analysis employed Monte Carlo simulation.

The final estimate for each program phase was the risk analysis output at the 90% confidence level. [Ref. 6:p. D-17]

5. Schedule Risks & Mitigation Strategy

The following paragraphs identify the principal areas of schedule risk existing for each phase in the AAAV program and explains the mitigation actions planned by the DRPM/AAAV for each risk area:

- <u>Demonstration & Validation Phase</u>- **Risk Assessment- Low**- The level of technical maturity of the AAAV program is exceptional for transition of MS I. As previously discussed, the Technical Base program and contractor projects conducted during the CE/D phase raised the level of maturity substantially. The schedule allows for 16 month fabrication phase, six months for combined shakeout/acceptance tests, eight months for DT-I, one month for refurbishment, and three months for OT-I. The eight month DT-I tests have been scheduled to accommodate prevailing ocean weather patterns at the test site. Test rates are taken from testing conducted at both APG and the Amphibian Vehicle Test Directorate (AVTD), Camp Pendleton, California. All required test and data reduction time requested by the independent testers has been included.

- <u>Engineering & Manufacturing Development Phase & Low Rate Initial Production</u>- **Risk Assessment- Low**- Sixty Nine months are allotted for the combination of EMD and LRIP. Twenty Four months are provided to incorporate changes identified during D&V phase testing. Nine months are allotted for combined shakeout/acceptance testing of the 11 prototypes. Twenty Three months are scheduled for DT-II testing, with a three month refurbishment before the IOT&E tests. Low Rate Initial Production award will not be made until 17 months of total testing has been completed. Twelve months are provided for the conduct of LFTE, and nine months for data reduction and reporting prior to the FRP MS. Upon award of the LRIP contract, 18 months are provided before delivery of the first LRIP vehicles. Low Rate Initial Production will produce 101 vehicles from an initial rate of two per month, or six per quarter, to the FRP rate of 50 per quarter. This rate increase will occur over a period of 28 months. The FRP rate is well below the maximum capacity of both contractors. [Ref. 6:pp. D-18-19]

L. SUMMARY

This chapter accomplished two major objectives. First, an explication of the AAAV program's historical development, current status and acquisition strategy was provided. Second, a chronicle of the risk management and mitigation strategies and techniques applied, on-going, and planned for the principal areas of risk identified in the AAAV literature data sources reviewed was furnished.

The product of the program documentation and literature review process is represented in the DSM for the AAAV Program, Appendix D. Specific risk management strategies and techniques are categorized and profiled as risk attributes in this matrix. As in Chapter II, Literature Review, the matrix technique used in this chapter provided the mechanism or vehicle to extract detailed information from numerous data sources. Application of this information gathering and organization technique can directly assist a PM or acquisition professional involved in the process of developing, comprehending, or improving their respective risk management program.

In Chapter IV, Analysis of Risk Management Methodologies, a comparative analysis of methodologies recommended in or prescribed by the risk management BOK with strategies and techniques described by AAAV program documentation will be conducted. The analysis draws upon data profiled in both DSMs (Appendices C and D), reconciles the specific risk management attributes contained in each domain, points out areas of convergence and divergence, and evaluates elements of the Spiral Model which show merit for application within the AAAV acquisition program.

IV. ANALYSIS OF RISK MANAGEMENT METHODOLOGIES

A. INTRODUCTION

The purpose of this chapter is to perform a comparative analysis of risk management methodologies employed in the AAAV acquisition program to methodologies contained in the risk management BOK. The analysis unifies and elaborates findings delivered in Section E of Chapter II and Section J of Chapter III.

This objective will be accomplished in three phases. First, Section B illustrates the extent to which the methodology implemented in the AAAV program merges with the methodology contained in the risk management BOK. Second, Section C examines the extent to which the AAAV programs' methodology diverges from the methodology contained in the risk management BOK. The relationship between these two domains is depicted pictorially in Figure 2 below. Finally, an evaluation of the Spiral Model's operational functions and primary features (attributes) which merit application in the AAAV program is presented in Section D.

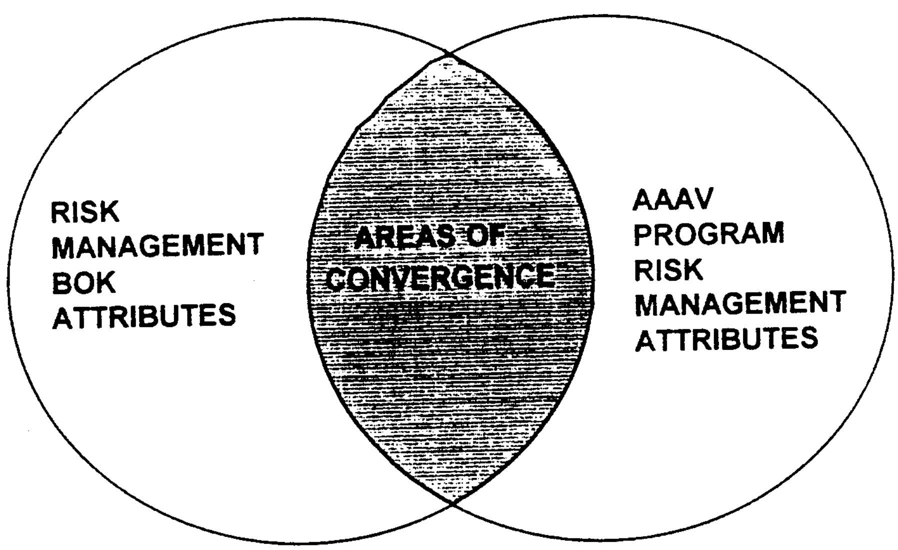

Figure 2. Pictorial Representation of Domain Relationships

B. AREAS WHERE RISK MANAGEMENT METHODOLOGIES CONVERGE

A comparative analysis between the two risk management methodologies reveals several notable areas of similar intent, purpose, and function. Areas of similarity or convergence between these two domains are derived from the respective risk management DSMs (Appendices C and D). The reader's attention to these matrices is invited.

Areas of convergence appear collectively at the sub-category level and individually at the risk attribute element level within a sub-category. The following subsections provide an analysis of 15 areas where attribute sub-categories and risk attributes converge between the two domains.

1. Risk Definitions

The risk management BOK provides definitions for numerous risk management terms and concepts. A subset of these definitions includes definitions to risk terms which function to qualify or rate specific technical risk factors. These terms include; Low Risk, Medium/Moderate Risk, and High Risk. The DRPM's risk management plan and methodology likewise furnishes definitions to terms which qualifying and rate risk areas.

2. Risk Management Planning

The risk management BOK requires the PM to establish a risk management plan. The risk management plan must incorporate a risk rating scheme and identify the frequency of risk analyses performed. Examination of the risk management DSM for the AAAV program (Appendix D) reveals that the DRPM has established a viable risk management plan. The DRPM's plan provides activities to be assessed during each program phase and at each MS decision.

3. Risk Assessment

The risk management BOK offers several strategies, techniques, and sources to be used in assessing program risks.

Particular emphasis is given to the assessment of technical risks. The risk management DSM for the AAAV program identifies eight risk areas targeted by the DRPM for continued risk assessment and evaluation. Further, the DSM discloses that a major technical risk assessment was performed on the Stratified Charge Rotary Engine (SCRE) for the AAAV.

4. Risk Analysis

The risk management BOK provides several methods to be used in examining, evaluating, and quantifying risk areas identified in a program. These methods include: 1) risk scoring/rating; 2) FMECA; 3) LCC Models and Estimates; 4) Monte Carlo simulation; and 5) Level of Repair Analysis. The DRPM's risk management methodology incorporated each of the five methods indicated above.

5. Risk Documentation

The risk management BOK identifies end user and customer participation early in the risk documentation process as paramount to a program's risk management effort. Furthermore, efforts to develop a historical database and to archive risk information are encouraged by the risk management BOK. The DRPM/AAAV placed these principles into practice by involving O&M personnel from active Fleet Marine Force (FMF) units in the risk documentation process. Fleet Marine Force personnel have and are actively participating in the commenting on and assessment of technical, safety, training, maintenance, and human factors issues in the AAAV development and design effort. Further, the DRPM has entered the results of risk analyses, technical data, and hardware configurations into the Defense Technical Information Center (DTIC) database.

6. Risk Mitigation

Risk mitigation techniques and strategies contained in the risk management BOK focus on technical risk areas. Risk mitigation techniques from the BOK include: 1) simulations; 2) use of component and full scale tests; 3) use of mock-ups;

4) logistics and maintainability demonstrations; 5) internal contractor reviews; and 6) identification of manufacturing and producibility issues and risks associated with design concepts and efforts to reduce them.

A cornerstone of the DRPM's risk mitigation effort has been the Technology Base program. The Technology Base program incorporated all of the above listed risk mitigation techniques and strategies. The program targeted high risk drivers of affordability, performance, and the known core operational requirements for early development and for the purpose of demonstrating the technical feasibility of HWS amphibious vehicles. The program was used as a springboard for more detailed development work during the CE/D phase.

Several risk reducing experiments have and continue to be performed by the DRPM office in concert with the two competing prime contractors (UDLP and GDLS). These risk reducing experiments include: 1) tests of major components and subsystems; 2) full scale vehicle mockups and tests; 3) ballistics and armor reparability tests; 4) construction and testing of contractor .75 and .80 scale HWS HTRs; and 5) M&S.

7. Risk Areas

In accordance with the risk management BOK, the DRPM has identified, categorized, and rated all major sources of program risk. Additionally, cost and technical risk areas and uncertainties existing or anticipated for each program phase have been identified.

Mitigation strategies and techniques to address each major risk area have been formulated or are being implemented by the DRPM. Major technical risk areas identified by the DRPM include: hull, suspension, propulsion, automotive drive train, marine drive unit, NBC, weapon station, communication and navigation equipment, S/W development, land and water mobility, weight control, test and evaluation, system integration, supportability, cost, and schedule.

8. Acquisition Strategy Considerations

In accordance with the risk management BOK, the DRPM has considered and selected an alternative and evolutionary acquisition strategy. The DRPM's strategy is entitled the "Paradigm Shift Model". Additionally, tailoring of the number of program phases and decision points as required by the risk management BOK to meet the unique needs of the AAAV program, has been accomplished. The tailoring activity was based upon program risks and supports the DRPM's overall risk management plan.

9. Development & Design Considerations

The risk management BOK asserts that accelerating a system development delays design maturation. As a result, numerous configuration changes can occur later in the program. An examination of the risk management methodology for the AAAV program reveals that the DRPM remains cognizant of this potential source of risk and has crafted an appropriate acquisition strategy. The DRPM's strategy incorporates the following eight major risk mitigation measures to support the AAAV development and design effort: 1) use of common subsystems and components in all AAAV mission role variants to the maximum extent possible; 2) plan for future upgrades in acquisition process; 3) application of "open architecture" and partitioned design to allow for significant growth or complete change-out of subsystems prone to rapid evolution or those that represent critical risk; 4) system design to design-in space, weight, power claims, channels, hard points, etc, to accommodate leap ahead, mature, and proven technologies infused from the DoD Science and Technology Thrust Areas; 5) establishment of development and in-service margins; 6) contractors' performance of concurrent engineering; 7) use of expert resources at the U.S. Army Tank Automotive Command (TACOM), specifically in land mobility and survivability, to assist in conceptual design of the AAAV; and 8) use of available COTS and low developmental or NDI components that have been ruggedized whenever possible.

10. Software Development & Design Considerations

As specified and recommended in the risk management BOK, the DRPM's risk management methodology also incorporates the following risk management/mitigation strategies and techniques: 1) use of Ada programming language for subsystems and Line Reparable Units (LRUs) that use microcomputers; 2) development and delivery of non-proprietary S/W documentation and source code; 3) contractor delivery of all S/W support tools and associated documentation necessary to maintain and upgrade S/W after system is deployed; 4) definition of interrelationships between H/W and S/W; 5) finalization of system level requirements through engineering studies, technology proving experiments, trade-off and optimization analyses; 6) prototyping, simulation and modeling; 7) joint involvement of user and developer in reviewing program status, products, risks, and plans for the next stage; 8) elimination of unattractive alternatives early and inexpensively in program acquisition cycle through down-select to a single contractor is a D&V phase acquisition activity; and 9) tailoring of acquisition strategy based upon risks and the risk management plan.

11. Prototyping & Technology Demonstration

The risk management BOK requires that PMs conduct technology demonstrations and aggressive prototyping (including manufacturing processes, H/W and S/W systems, and critical subsystems) coupled with EOAs. Competitive prototyping of critical systems is also recommended.

For the AAAV program, advanced technologies were developed for every vehicle subsystem. Subsystems were systematically integrated and tested in a series of successively more complex operational demonstrators including a .55 scale HWS model, and a .75 scale PSD.

Full-scale prototype development and testing of the HWS vehicles are necessary and planned to resolve principal areas of technical risk. Fabrication and testing of sub-scale components have been accomplished. This has allowed the incorporation of more refined concepts into the D&V detailed design effort with less risk. Additionally, use of ATRs as a risk reducing activity is planned. This activity will identify high risk drivers and will facilitate evaluation of the first generation AAAV track and suspension components.

Both competing prime contractors are developing and will produce prototypes early in the acquisition process (D&V). The D&V prototype will be used to reduce program risk through determination of technical deficiencies in subsystems and in operational modes that will be corrected in the EMD phase.

12. Testing Considerations

The risk management BOK identifies the following testing methodologies, strategies, and techniques as critical to a program's risk management and mitigation effort. The DRPM's risk management methodology contains the same attributes: 1) combining DT and OT where feasible and practical; 2) identification of specific testing activities to be accomplished during each acquisition phase; 3) use of simulation and modeling by the contractor and the development agency to demonstrate and assess capabilities of key subsystems and components; 4) use of studies, simulations, analyses, and test data to explore and evaluate alternative concepts proposed; and 5) use of private testing laboratories and facilities if scheduling conflicts arise or cost or schedule savings to the Government can be realized.

As mentioned in Chapter III, Section J, Subsection 2, AAAV data sources neither explicitly nor implicitly acknowledge problems potentially emerging from or associated with the employment of an "evolutionary" acquisition strategy but supported by a "classical" test and evaluation (T&E)

approach. The author views this issue as a thesis topic area warranting further research by NPS students.

13. Contract Management

The risk management BOK identifies contract management considerations as attributes of a viable risk management program. The DRPM's risk management methodology contains the same attributes: 1) early identification of contractual requirements; 2) early competitive award as risk reducing technique; 3) consideration of NDI and COTS subsystems and components; 4) require competing contractors to identify, assess, and eliminate risk areas or reduce them to acceptable levels; 5) increase Government attention to subcontractor activities as risk reducing method; 6) consideration of combined procurement of end items, spares, and repair parts; 7) contract provisions for material support (GFE and assistance in tooling and test equipment development); 8) ensure compliance with DoD priority designation system; 9) encourage stable system design; 10) D&V contract to maximize subcontracting competition, using the "Competition in Subcontracting Clause" (FAR 52.244-5); and 11) planning for a component breakout review once a D&V contractor is selected.

14. Cost & Budgeting Considerations

The risk management BOK provides the PM techniques for managing and mitigating cost and budgeting risks. Techniques identified in the risk management BOK which have also been employed by the DRPM/AAAV include: 1) early identification and management of cost drivers which have significant impact on readiness; 2) early isolation of LCCs; 3) performance of trade-off analyses involving leading cost drivers; 4) Monte Carlo simulation; 5) LCC modeling; and 6) estimating relationships (actuals from the M1 MBT, BFV, PSD, and other similar development and production programs).

15. Logistics Management

The risk management BOK provides several techniques for managing and mitigating supportability/ILS risks. Techniques recommended in the risk management BOK which have been and continue to be employed by the DRPM/AAAV include: 1) use of DT to initially assess maintainability/logistics supportability; 2) use of LSA and level of repair analysis programs early in the acquisition process to validate AAAV provisioning objective (this activity continues through the FRP and deployment phase); 3) identification of the number of operational and support personnel, facilities, and organizational, intermediate, and depot support elements that must be in place to support IOC and FOC as early in the development process as possible; 4) identification, assessment, and analysis of supportability risks; and 5) logistics and maintainability demonstrations to enable incorporation of these concerns into the system design.

C. AREAS WHERE RISK MANAGEMENT METHODOLOGIES DIVERGE

A comparative analysis between the two risk management methodologies also reveals several areas of dissimilar intent, purpose, and function. Areas of dissimilarity or divergence between these two domains are derived from the respective risk management DSMs (Appendices C and D). The reader's attention to these matrices is invited.

Areas of divergence appear collectively at the sub-category level and individually at the risk attribute element level within a sub-category. The following subsections identify, and provide a detailed analysis of: 1) five distinct risk attribute sub-categories explicitly profiled in the risk management BOK which are not similarly profiled in the AAAV program methodology; and 2) two distinct risk attribute sub-categories explicitly profiled in the AAAV program methodology which are not similarly profiled in the risk management BOK.

1. Risk Management Concepts

This area of divergence represents a distinct sub-category of risk attributes profiled in the risk management BOK (Appendix C) not similarly profiled in the AAAV program risk management methodology (Appendix D). Instead, attributes of this sub-category are disseminated to, subordinated to, and thus profiled within other attribute sub-categories of the AAAV program's methodology.

The following comments illustrate this observation: 1) the risk management BOK offers two perspectives of the risk management process: short term and long term. This perspective is not explicitly articulated in the risk management methodology for the AAAV program (Appendix D). This perspective is, however, implied and discernible from the risk mitigation activities implemented or planned by the DRPM/AAAV; and 2) the risk management BOK explicitly recommends management of risks associated with four areas of a program's environment (i.e., external risks). These areas include; external influences, interfaces, project stakeholders, and public relations programs.

The risk management methodology for the AAAV program acknowledges these facets of the program's environment but does not identify the specific risk mitigation techniques to be applied nor reveal the elements of a broader, unifying risk management strategy aimed at addressing external risk areas. This is attributable to the lack of explicit or implicit policy and guidance from the DoD regarding the identification, assessment, analysis, and mitigation of external risks.

2. Risk Assessment

An attribute of this sub-category of the risk management BOK DSM explicitly recommends that PMs provide focused training to personnel involved in risk assessment activities. The risk management DSM for the AAAV program (Appendix D) did not similarly profile this attribute.

3. Risk Identification

As in the area of "Risk Management Concepts", this area of divergence represents a distinct sub-category of risk attributes resident in each domain but in differing forms. The risk identification process presented in the risk management BOK (Appendix C) recommends various techniques for the PM to use in gaining information relating to program risks. These techniques include; expert interviews, independent technical assessments, sources of objective information, and in-house design reviews.

The risk management methodology for the AAAV program contains many of the same methods but under different risk attribute sub-categories. For example; the DRPM's conduct of in-house/in-process reviews is profiled as a risk attribute of the "Risk Management Planning" sub-category. Additionally, the DRPM's application of independent technical assessments [Ref. 11] is profiled as a risk attribute of the "Risk Assessment" sub-category.

4. Manufacturing Considerations

The risk management BOK: 1) defines the concept of "Manufacturing Risk Assessment"; 2) makes differentiations between categories of manufacturing processes and materials; and 3) requires the demonstration of experimental material in the factory prior to a demonstration in the manufacturing environment.

These manufacturing considerations relate to activities commensurate with the EMD and later phases of the acquisition process and are currently not explicitly profiled in the risk management methodology for the AAAV program (Appendix D). This divergency is, however, attributed to the fact that the AAAV program is in the CE/D phase and is consequently not engaged in manufacturing processes nor in risk mitigation activities associated with manufacturing processes.

5. Schedule Considerations

The risk management BOK: 1) identifies the program schedule as subject to trade-off as a method of mitigating risk; and 2) recommends the PM employ the network schedule to identify deployment activities.

These program schedule considerations relate to activities commensurate with the EMD and later phases of the acquisition process and are currently not profiled in the risk management methodology for the AAAV program (Appendix D). As in "Manufacturing Considerations", this divergency is attributed to the fact that the AAAV program is in the CE/D phase and is, therefore, not actively engaged in detailed process scheduling, manufacturing activities, nor system deployment activities.

6. Warranty Considerations

The risk management BOK: 1) identifies warranty risk items; 2) suggests techniques for minimizing warranty risks; and 3) recommends that warranty considerations be integrated by the PM into the program's acquisition strategy. The author's examination of the AAAV program risk management methodology did not detect a similar explicit presentation nor formal acknowledgement of warranty considerations appropriate for a program in the CE/D phase.

7. Modeling & Simulation

A fundamental purpose of M&S for the DoD is to "test" what benefits technology can bring in buying weapon systems [Ref. 12]. An examination of the risk management BOK reveals that M&S techniques are presented as risk attributes within the Test and Evaluation (T&E) attribute sub-category. This presentation differs substantially from the AAAV program's treatment and presentation of M&S techniques.

For the AAAV program, the DRPM is aggressively employing M&S as a major and distinct risk management initiative complementary but not subordinate to the DRPM's T&E effort.

Specifically, the DRPM/AAAV has elevated M&S and is allocating special resources to address three objectives: 1) What can M&S bring to the AAAV acquisition process?; 2) Will M&S technology produce cost savings for the AAAV acquisition program?; and 3) Can simulation systems acquired for testing also be used for training?.

To facilitate the study of these objectives, the AAAV program office has teamed with and is receiving funding and technical support from the Defense Modeling and Simulation Office (DMSO). Additionally, both competing prime contractors will make extensive use of advanced computer modeling and simulation. Together, the DRPM and DMSO intend to use the AAAV program as a test case for M&S with lessons learned to be shared with other military Services. The author views this topic as a subject area warranting future research by subsequent thesis students.

8. Systems Integration

An analysis of the risk management BOK reveals that systems integration attributes are subsumed and/or subordinated within other risk attribute sub-categories. For example, the attribute sub-category "Risk Analysis" identifies Human Factors Analysis as an example of a risk analysis method. Other examples of this subordinating tendency abound.

The AAAV program risk management methodology treatment and classification of systems integration issues differs markedly. The usual parameters within which a PM operates are performance, cost, and schedule. Since degradation in the Human Systems Integration (HSI) domains will adversely impact system performance and LCC, the decision was made to design the AAAV to meet the threat while recognizing the capabilities and limitations of the intended users.

To decrease overall risk in the AAAV program, HSI has been designated by the DRPM as an additional parameter and as such became a separate risk management initiative.

The DRPM's methodology discloses that HSI has been elevated to a separate functional discipline area within the AAAV program office structure. The AAAV/HSI section has been tasked by the DRPM with: 1) using DoD HSI methodology to determine Manpower, Personnel, Training, Human Factors Engineering, Safety and Health Hazards requirements; and 2) the objective to reduce manpower requirements for operators and maintainers below that currently required to support the AAV7A1.

Of paramount importance to the DRPM is the integration of human factors for environmental cooling systems for the crew and passengers into the conceptual design for the new AAAV. The DRPM's risk management strategy acknowledges the potential risk associated with the limited operational effectiveness, costly modifications, and understated cost estimates if human factors for this feature are omitted from the AAAV design. [Ref. 13] The author also views this topic as a subject area warranting future research by subsequent thesis students.

D. ANALYSIS OF THE "SPIRAL MODEL"

1. Overview

A subsidiary research question of this thesis asks whether the "Spiral Model of Software Development and Enhancement," as developed and presented by Barry W. Boehm of the Defense Systems Group, TRW Corporation, can be applied in non-software development efforts such as the AAAV program. This research question is evaluated with respect to the model's risk attributes in two areas. First, Subsection 2 explains the model's operational functions and discusses operational attributes which merit application to the AAAV program. Second, Subsection 3 explains the model's primary features and identifies those attributes which merit application in the AAAV program. To demonstrate attributes of the Spiral Model that converge with and/or diverge from the AAAV program risk management methodology, information presented in: 1) Chapter III, The Advanced Amphibious Assault Vehicle Program; 2) Appendix D, DSM for the AAAV Program; and 3) earlier in this chapter; will be referenced periodically to ensure analytical continuity.

At the outset it should be noted that the author in presenting the model has made a deliberate attempt to omit explicit reference to the type of product or system (material or non-material, software or non-software) which is the subject of a development and acquisition effort. The ease in transforming the model is, by itself, an attribute which affirms the author's premise that the model possesses a strong potential for application to non-software material development programs such as the AAAV.

Note: Information in this section which relates exclusively to the Spiral Model was derived principally from the risk management BOK data source #23 (Boehm, B.W., "A Spiral Model of Software Development and Enhancement", Software Management, IEEE Computer Society Press, CA., 1993).

2. Model Functions

According to Boehm, the primary functions (attributes) of a system development process model such as the Spiral Model are to determine the "order of the stages" involved in system development and evolution and to establish the "transition criteria" for progressing from one stage to the next. These include completion criteria for the current stage plus choice criteria and entrance criteria for the next stage. By design, a system process model provides guidance on the order in which a program should carry out its major tasks. Thus, Boehm's Spiral Model addresses the following project questions:

1. What shall we do next?

2. How long shall we continue to do it?. [Ref 4:p. 120]

A review of the AAAV program risk management DSM (Reference Attribute Sub-Categories- Risk Management Planning, Risk Assessment, Risk Areas, Acquisition Strategy, Testing, Software Design and Development) reveals that this same approach is manifested and demonstrated in the AAAV program's acquisition strategy, acquisition schedule, and risk management plan.

The Spiral Model is depicted in Figure 3. The radial dimension of this model represents the cumulative cost incurred in accomplishing the steps to date; the angular dimension represents the progress made in completing each cycle of the spiral. The Spiral Model reflects the underlying concept that each cycle involves a progression that addresses the same sequence of steps, for each portion of the product, and for each of its levels of elaboration. [Ref. 4:p. 124]

Each cycle of the spiral commences with the identification of: 1) the objectives of the portion of the product being elaborated (performance, functionality, and ability to accommodate change); 2) the alternative means of implementing this portion of the product; and 3) the constraints imposed on the application of alternatives (cost, schedule, and interface). The next step is to evaluate the alternatives relative to the objectives and constraints.

Frequently, and as delineated in the AAAV program risk management DSM (Reference Attribute Sub-Categories- Risk Analysis, Risk Assessment, Risk Mitigation, Development and Design), this process will identify areas of uncertainty that are significant sources of program risk. If so, the next step involves the development of a cost effective risk resolution strategy.

This risk resolution strategy may involve prototyping, simulation, benchmarking, reference checking, user questionnaires, analytic modeling, or combinations of these and other risk resolution techniques. [Ref. 4:p. 124]

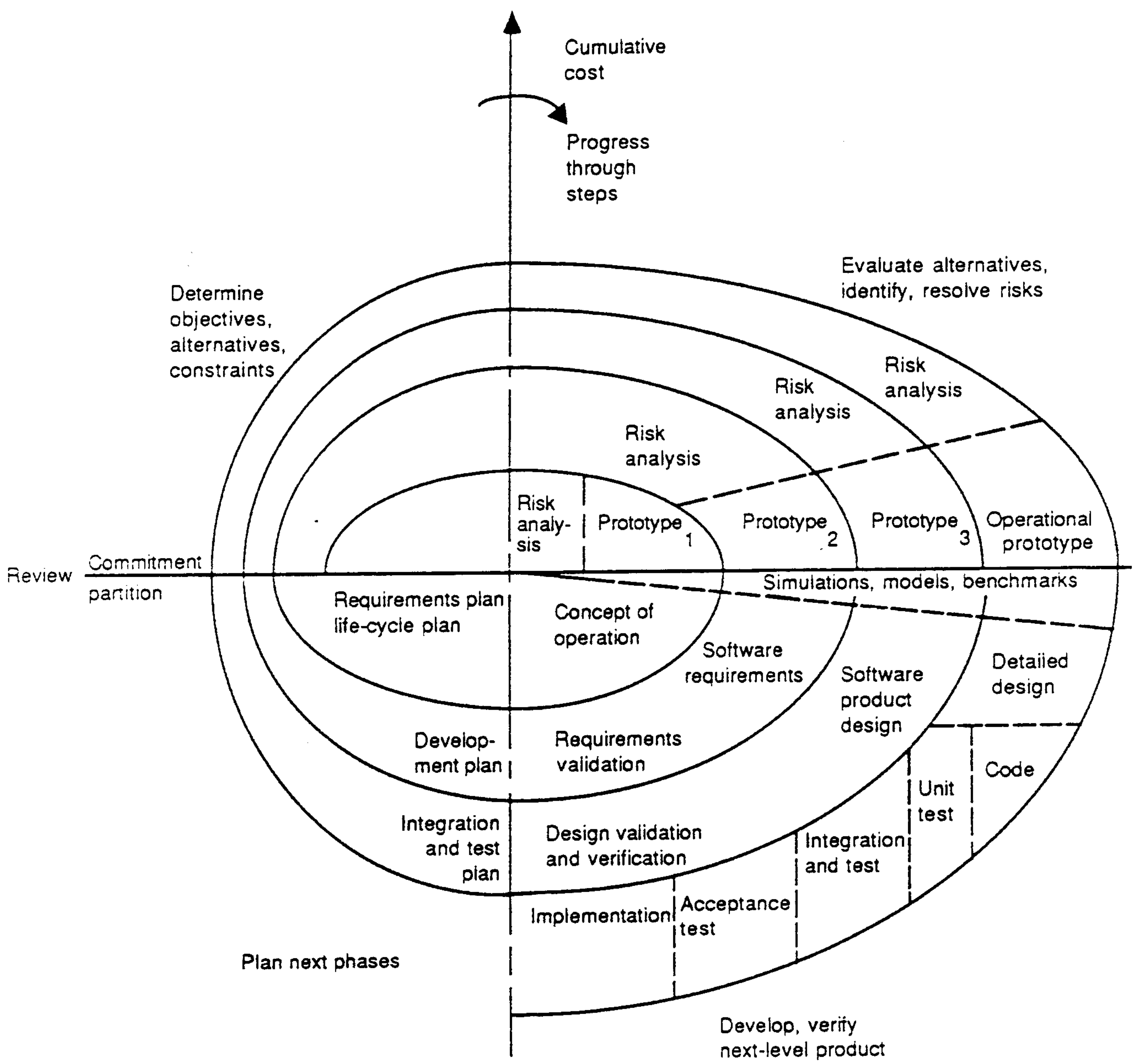

Figure 3. The Spiral Model

The AAAV program's risk management methodology incorporates each of the above listed attributes (Reference Attribute Sub-Categories- Risk Analysis, Risk Mitigation, Development and Design, Prototyping and Technology Demonstration, Modeling and Simulation).

Boehm poses four fundamental questions that arise in considering the practicality and functionality of the Spiral Model:

1. How does the spiral ever get started?

2. How do you get off the spiral when it is appropriate to terminate a project early?

3. Why does the spiral end so abruptly?

4. What happens to system enhancement?

The answer to these questions involves an observation that the Spiral Model applies equally to development or enhancement efforts. In either case, the spiral gets started by a hypothesis that a particular operational mission(s) could be improved by an acquisition effort. The spiral process then involves a test of the hypothesis. If the hypothesis fails the test, the spiral is terminated. Otherwise the spiral is terminated with the physical delivery and employment of the system, and the hypothesis is tested by observing the effect on the operational mission. Usually, experience with the operational mission leads to a further hypothesis about system improvements, and a new enhancement spiral is initiated to test the hypothesis. Initiation, termination, and iteration of the tasks and products of previous cycles are thus implicitly defined in the Spiral Model. [Ref. 4:p. 124]

The AAAV "open architecture" and partitioned design coupled with the Pre-Planned Product Improvement acquisition strategy reveals that the Spiral Model possesses attributes which address the AAAV program enhancement effort (Reference

Attribute Sub-Categories- Acquisition Strategy, Development and Design).

3. Model Features

Boehm argues that the major distinguishing feature of the Spiral Model is that it creates a "risk driven" approach to a system development process rather than a "primarily document" driven approach [Ref. 4:p. 120]. It is this explicit orientation of the Spiral Model to the risk management discipline which qualified the model for inclusion into the risk management BOK. Accordingly, Boehm's article is listed in Chapter II, Literature Review, Section D, as an item of literature sampled for examination. As prescribed by the literature review methodology, the risk management BOK DSM, Appendix C, profiles the risk attributes featured in this particular data source.

Another significant feature of the Spiral Model is that each cycle is completed by a review involving the primary people or organizations concerned with the product. This review covers all products developed during the previous cycle, including the plans for the next cycle and the resources required to carry them out. The review's major objective is to ensure that all concerned parties are mutually committed to the approach for the next phase.

An examination of the risk management methodology employed in the AAAV program reveals the following attributes which reflect an intent, purpose, and function similar to the attributes discussed in the paragraph above:

- The DRPM/AAAV conducts in-process reviews with the contractors to determine likelihood of delivering engine on time. (Reference Attribute Sub-Category- Risk Management Planning).

- The DRPM/AAAV involves the product end user in risk documentation activities. (Reference Attribute Sub-Category- Risk Documentation).

- The DRPM/AAAV demonstrated the PSD to program stakeholders. (Reference Attribute Sub-Category- Risk Mitigation).

- The DRPM/AAAV submitted and obtained favorable endorsements from the Office of Chief of Naval Research regarding technical risk reducing activities. (Reference Attribute Sub-Category- Risk Mitigation).

- The DRPM/AAAV uses O&M personnel from FMF units at contractor facilities to comment on and assess technical, safety, training, maintenance, and human factors issues of the design. (Reference Attribute Sub-Category- Risk Documentation).

- The DRPM/AAAV uses multi-disciplined teams, computer aided tools, and other system engineering tools by contractors to apply concept of concurrent engineering in development and production. (Reference Attribute Sub-Category- Development and Design).

Boehm lists four other important features of the Spiral Model including:

> 1. It fosters the development of specifications that are not necessarily uniform, exhaustive, or formal, in that they defer detailed elaboration of low-risk elements until the high-risk elements of the design are stable.
>
> 2. It incorporates prototyping and simulation as a risk reduction technique at any stage of development. This attribute is similarly contained in the risk management methodology for the AAAV program. (Reference Attribute Sub-Categories- Prototyping and Technology Demonstration, Modeling and Simulation).
>
> 3. It accommodates reworks or go-backs to earlier stages as more attractive alternatives are identified or as new risk issues need resolution.
>
> 4. It facilitates the use of risk driven documents, particularly specifications and plans as risk management tools. [Ref. 4:p. 127]

Boehm acknowledges that efforts to apply the Spiral Model focus on creating a discipline of risk management which includes techniques for risk identification, risk analysis, risk prioritization, risk management planning, and risk tracking. The risk management methodology for the AAAV program also explicitly contains techniques for risk analysis, and risk management planning. The remaining techniques--risk identification, risk prioritization, and risk tracking--are subsumed and/or subordinated within the risk assessment and risk areas attribute sub-categories.

Boehm states that one product of this activity is the development of a prioritized "top 10 list" of program risk items. Another product is the formation of a "Risk Management Plan" illustrated in Table 1 below. [Ref. 4:pp. 129-130]

1. Identify the project's top 10 risk items.
2. Present a plan for resolving each risk item.
3. Update list of top risk items, plan, and results monthly.
4. Highlight risk-item status in monthly project reviews.
   * Compare with previous month's rankings, status.
5. Initiate appropriate corrective actions.

Table 1. Risk Management Plan.

The Risk Management Plan ensures that each project makes an early identification of its top risk items (the number 10 is not an absolute requirement), develops a strategy for resolving the risk items, identifies and sets down an agenda to resolve risk items as they surface, and highlights progress versus plans in monthly reviews.

An evaluation of the risk management methodology for the AAAV program reveals that the DRPM/AAAV has established a risk management plan, and has developed a risk mitigation strategy. The risk management methodology for the AAAV program does not, however, make explicit reference to a prioritized "top 10 list" of program risk items. (Reference Attribute Sub-Categories- Risk Management Planning, Risk Mitigation).

As noted earlier, the Spiral Model with the aid of the Risk Management Plan, and the DRPM/AAAV with the aid of the risk management methodology, focus on early prototyping, simulation, modeling, benchmarking, and other risk resolving techniques to help avoid potential program "show-stoppers." The Risk Management Plan and the maturing set of techniques for risk management provide a foundation for tailoring and adopting Spiral Model concepts into the more established system acquisition and development procedures employed in the AAAV program. [Ref. 4:p. 130]

E. SUMMARY

This chapter delivered a comparative analysis of risk management methodology implemented in the AAAV acquisition program to methodology recommended and/or prescribed by the risk management BOK. The analysis reveals: 1) five distinct risk attribute sub-categories explicitly profiled in the risk management BOK which are not similarly profiled in the AAAV program methodology; and 2) two distinct risk attribute sub-categories explicitly profiled in the AAAV program methodology not similarly profiled in the risk management BOK. Finally, an analysis of the Spiral Model concluded that there are several attributes of the model which merit application within the AAAV acquisition program.

V. CONCLUSIONS & RECOMMENDATIONS

A. OVERVIEW

The focus of this research effort was to examine and compare risk management attributes (concepts, policy, guidance, strategies, and techniques) delineated in the risk management BOK and in the U.S. Marine Corps AAAV program. The conclusions and recommendations drawn from this evaluation are not intended to criticize individuals and organizations responsible for formulating and promulgating risk management policy and instruction for the DoD. Similarly, they are not intended to criticize the performance of individuals and organizations involved in the AAAV risk management methodology development process. Rather, this analysis suggests potential areas of opportunity for improving the AAAV program's risk management process, and highlight logical enhancements to the overall risk management BOK. Based on this study the following conclusions and recommendations are made.

B. CONCLUSIONS

1. <u>The DSM technique used in this thesis provided a viable mechanism to extract detailed information from numerous research data sources.</u>

The DSM technique presents clear advantages to Defense Systems Management College, Naval Postgraduate School, and other faculty and students involved in research activities. The DSM technique can be easily tailored to accommodate inherently quantitative/empirical data, as well as qualitative information. Furthermore, application of this information gathering and organization technique can directly assist any acquisition professional involved in the process of developing, comprehending, or improving their respective risk management program.

2. <u>The DRPM/AAAV, PM, or any acquisition professional could benefit from applying the risk management BOK DSM as a tool to formulate or improve their risk management plan.</u>

Program Managers tasked with initially developing or revising their risk management plans would benefit from consulting all available systems acquisition and program management literature and documents which provide policy, regulation, and guidance. The breadth of this literature is extensive and includes, but is not limited to, the following categories: 1) OSD memorandums, reports and initiatives; 2) OMB Circular A-109 <u>Major Systems Acquisitions</u>; 3) DoD Directives and Instructions; 4) Service specific regulations; and 5) Military Standards (MIL-STDs).

Supplementing Federal policy documents and Service department directives are literature resources available from academia and from private sector institutions. Major literature resources available to the PM from this latter category include the current family of technical guidebooks published by the DSMC and the series of management handbooks published by the PMI.

In the aggregate, the segment of program management literature which pertains to the discipline of risk management composes the risk management BOK. The risk management BOK offers a substantial sample and range of risk management and mitigation policies, guidance, strategies, and techniques. The domain of risk management strategies and techniques was evaluated for its functional purposes, was assembled into 20 distinct risk management sub-categories, and was presented collectively in the risk management BOK DSM (Appendix C). Each sub-category profiled individual risk attributes discerned from the literature review process. The military acquisition professional preparing to undertake a risk management program should use the risk management BOK DSM in formulating or improving their risk management plan.

3. <u>The DRPM/AAAV has employed a coherent and comprehensive risk management plan, which effectively addresses and mitigates known program risks, and which converges markedly with the risk management BOK.</u>

The risk management methodology employed in the AAAV program offers a multi-functional, mutually supporting range of risk management strategies and techniques to mitigate the principal areas of technical, supportability, cost, and schedule risks identified by the DRPM/AAAV. Attributes of the DRPM's methodology were evaluated for their functional purpose and were assembled into 17 distinct risk management sub-categories. Each sub-category profiled individual risk attributes discerned from the AAAV program management documentation and literature review process. The domain of risk management attributes was presented collectively in the risk management DSM for the AAAV program (Appendix D). A comparative analysis between the two domains revealed 15 notable areas of similar intent, purpose, and function. Areas of convergence appeared collectively at the risk attribute sub-category level and individually at the risk attribute element level within a sub-category.

4. <u>Some differences exist between the risk management methodology recommended and/or prescribed in the risk management BOK and the AAAV program risk management methodology.</u>

A comparative analysis of risk management methodology implemented in the AAAV acquisition program to methodology recommended and/or prescribed by the risk management BOK revealed five distinct risk attribute sub-categories (Risk Management Concepts, Risk Identification, Manufacturing Considerations, Schedule Considerations, and Warranty Considerations) explicitly profiled in the risk management BOK which were not similarly profiled in the AAAV program methodology.

The analysis also revealed two distinct risk attribute sub-categories (Modeling and Simulation, and Systems Integration) explicitly profiled in the AAAV program methodology which were not similarly profiled in the risk management BOK.

5. <u>The risk management and mitigation methodology implemented in the AAAV acquisition program contributes to the overall risk management BOK.</u>

There are two main areas where this contribution occurs. First, is the Modeling and Simulation (M&S) domain. The DRPM is aggressively employing M&S as a major and distinct risk management initiative complementary but not subordinate to the program's T&E effort. Additionally, the DRPM's allocation of special resources to the M&S effort firmly positioned the program to address three objectives: 1) What can M&S bring to the AAAV acquisition process?; 2) Will M&S technology produce cost savings for the AAAV acquisition program?; and 3) Can simulation systems acquired for testing also be used for training?. Second is the Systems Integration domain. The AAAV program risk management methodology treatment and classification of Systems Integration issues differs markedly from the risk management BOK. The usual parameters within which a PM operates are performance, cost, and schedule. To decrease overall risk in the AAAV program, Human Systems Integration (HSI) has been designated by the DRPM/AAAV as an additional parameter and as such became a separate risk management initiative. These findings support the author's premise that each Service can learn and benefit from the successes of AAAV program's risk management methodology.

6. <u>There are attributes of "Spiral Model" which are and which can be applied within the AAAV acquisition program.</u>

The Spiral Model with the aid of the Risk Management Plan, and the DRPM/AAAV with the aid of the risk management methodology, focus on early prototyping, simulation, modeling, benchmarking, and other risk resolving techniques to help avoid potential program "show-stoppers." The Risk Management Plan and the maturing set of techniques for risk management provide a foundation for tailoring and adopting Spiral Model concepts into the more established system acquisition and development procedures employed in the AAAV program.

C. RECOMMENDATIONS

1. That the Naval Postgraduate School, Defense Systems Management College, and other Defense Acquisition University (DAU) institutions encourage resident faculty and students to use the DSM technique when appropriate for research applications.

2. That the DRPM/AAAV, PM, and military acquisition professionals consider the risk management BOK in the formulation or improvement of their risk management plan.

3. That the DRPM/AAAV investigate establishing a systems integration working group consisting of: 1) representatives of the AAAV program office; 2) representatives of the Marine Corps supporting establishment; 3) representatives of the user community; and 4) representatives of industry. The objective of this group is to identify, analyze, and resolve system integration issues. This will unify the presentation of systems integration issues to the Marine Corps and to industry and optimize total system performance, minimize LCC, and mitigate program risks.

4. That the DRPM/AAAV consider conducting, at a minimum, two risk assessments, early and late, in each acquisition phase. This assessment frequency complies with the GAO's recommendation #2 contained in reference 2 of this thesis.

5. That the Office of the Secretary of Defense (OSD) consider standardizing definitions of risk management terminology and concepts and provide precise but flexible risk management guidelines when formulating or revising acquisition policy.

6. That the DRPM/AAAV evaluate specifying a contractor risk assessment program as a separate management criterion in the D&V contract source selection evaluation process.

7. That the DRPM/AAAV investigate the feasibility, advantages, and disadvantages of implementing a risk driven, cyclic, process development model, such as the Spiral Model, within the AAAV acquisition program.

D. AREAS FOR FURTHER RESEARCH

1. Analysis of the application of Modeling and Simulation (M&S) as a risk mitigation technique. Students selecting this research topic could investigate the role and mission of the DMSO, perform case studies, and analytically compare M&S efforts of previous and active DoD weapon system acquisition programs.

2. Investigate critical HSI issues affecting predecessor and comparable DoD system acquisition programs. Students selecting this research topic could perform case studies, and conduct comparative analyses between HSI efforts on-going in DoD acquisition programs.

3. Investigate the feasibility, advantages, and disadvantages of implementing risk driven, cyclic, process development models, such as the Spiral Model, within DoD weapon system acquisition programs.

4. Investigate the feasibility, cost, and merit of the selected AAAV D&V prime contractor implementing the Contractor Risk Assessment Program (CRAG).

5. Study the policies, guidance, and instruction published by the Department of Defense relating to the identification, assessment, analysis, and mitigation of external risks within DoD weapon systems acquisition programs. Students selecting this topic could perform a comparative analysis of DoD employed methodologies with methodologies employed by private sector institutions.

6. Investigate policies and procedures of the U.S. Marine Corps, the DRPM/AAAV, and prime contractors to ensure control and accountability of Government Furnished Material (GFM) and Government Furnished Equipment (GFE) in support of the AAAV acquisition program.

7. Study the Marine Corps' plans for Integrated Logistics Support (ILS) of the AAAV system once fielded. Students could evaluate: 1) proposed and alternative maintenance support scenarios; 2) facilities requirements; 3) spare parts and secondary reparable provisioning; and 4) Table of Equipment (T/E) material allowance and allocation issues.

8. Study issues associated with the impact of the new AAAV system on the environment. For example, students could evaluate the environmental impact of the Marine Corps plan for developing, and maintaining a Chemical Agent Resistant Coating (CARC) operation in support of the fielded AAAV system.

9. Investigate issues, feasibility, advantages, and disadvantages associated with the DRPM/AAAV employment of an "evolutionary" acquisition strategy but supported by a "classical" test and evaluation (T&E) approach.

10. Investigate Marine Corps' plans for design, development, and integration of software into the AAAV system, subsystem, and components.

11. Investigate methods of encouraging production competition at the prime AAAV contractor level. Students selecting this topic could research and analyze the implications of the detailed component breakout review planned for the D&V phase.

APPENDIX A. LIST OF ABBREVIATIONS & ACRONYMS

AAA	Advanced Amphibious Assault
AAAV	Advanced Amphibious Assault Vehicle
AAV	Amphibious Assault Vehicle
ACAT	Acquisition Category
ACMC	Assistant Commandant of the Marine Corps
ADM	Acquisition Decision Memorandum
AFS	Advanced Filtration System
AFV	Armored Family of Vehicles
AHP	Analytic Hierarchy Process
APC	Armored Personnel Carrier
APG	Aberdeen Proving Grounds
APPDM	Automated Program Planning Documentation
ATD	Advanced Technology Demonstrator
ATR	Automotive Test Rig
AVTD	Amphibian Vehicle Test Directorate
BH&T	Ballistic Hull and Turret
BOK	Body of Knowledge
CARC	Chemical Agent Resistant Coating
CART	Corrective Action Review Team
CDR	Critical Design Review
CE/D	Concept Exploration and Definition
CM	Configuration Management
CMC	Commandant of the Marine Corps
CMP	Configuration Management Plan
CNA	Center for Naval Analysis
CNR	Center for Naval Research
COEA	Cost and Operational Effectiveness Analysis
COTS	Commercial Off-The-Shelf
CPAF	Cost-Plus-Award-Fee
CPIF	Cost-Plus-Incentive-Fee
CPR	Cost Performance Report
CRAG	Contractors Risk Assessment Guide
C/SCSC	Cost/Schedule Control Systems Criteria
DAB	Defense Acquisition Board
DAU	Defense Acquisition University
D&V	Demonstration and Validation
DEMVAL	Demonstration and Validation
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DRB	Defense Resources Board
DRPM	Direct Reporting Program Manager
DSM	Data Source Matrix
DSMC	Defense Systems Management College
DT	Development Test
DT&E	Development Test and Evaluation
DTIC	Defense Technical Information Center
EDCAS	Equipment Designers Cost Analysis System

EMD	Engineering and Manufacturing Development
EOA	Early Operational Assessment
ERDEC	Environmental Research, Development, and Engineering Command
FAR	Federal Acquisition Regulation
FAT	First Article Testing
FCA	Functional Configuration Audit
FFP	Firm-Fixed-Price
FMECA	Failure Modes Effects and Criticality Analysis
FMF	Fleet Marine Force
FMS	Foreign Military Sales
FOC	Full Operational Capability
FOT&E	Follow-On Test and Evaluation
FQR	Formal Qualification Review
FRP	Full-Rate Production
FY	Fiscal Year
GAO	General Accounting Office
GDLS	General Dynamics Land Systems
GFE	Government Furnished Equipment
GFM	Government Furnished Material
HSI	Human Systems Integration
HTR	Hydrodynamic Test Rig
H/W	Hardware
HWS	High Water Speed
HWSTD	High Water Speed Technology Demonstrator
ICE	Independent Cost Estimate
IEEE	Institute of Electrical and Electronic Engineers
IG	Inspector General
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IPL	Integrated Priorities List
IPS	Integrated Program Summary
IR&D	Independent Research and Development
JROC	Joint Requirements Oversight Council
LCAC	Landing Craft Air Cushion
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LFT&E	Live Fire Test and Evaluation
LRIP	Low Rate Initial Production
LRU	Line Reparable Unit
MAA	Mission Area Analysis
MBT	Main Battle Tank
MCCDC	Marine Corps Combat Development Center
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MDA	Milestone Decision Authority
MIL-STD	Military Standard
MNS	Mission Need Statement
MP	Manufacturing Plan

MS	Milestone
M&S	Modeling and Simulation
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, Chemical
NDI	Non-Developmental Item
NSWC	Naval Surface Warfare Center
OA	Operational Assessment
OAT	Office of Advanced Technology
O&M	Operations and Maintenance
O&S	Operations and Support
OMB	Office of Management and Budget
OMFTS	Operational Maneuver from the Sea
ONR	Office of Naval Research
OOA	Object Oriented Approach
ORD	Operational Requirements Document
OT	Operational Test
OTA	Operational Test Agency
OTH	Over the Horizon
OT&E	Operational Test and Evaluation
OTS	Off-The-Shelf
OSD	Office of Secretary of Defense
PCA	Physical Configuration Audit
PDM	Program Decision Memorandum
PDR	Preliminary Design Review
PERT	Program Evaluation Review Technique
PM	Program Manager
PMI	Project Management Institute
PMP	Program Management Plan
POM	Program Objective Memorandum
PPS	Post Production Support
PRR	Production Readiness Review
PSD	Propulsion System Demonstrator
PTLD	Physical Teardown and Logistics Demonstration
QA	Quality Assurance
QTR	Quarter
RFP	Request for Proposal
RMP	Risk Management Plan
SCRE	Stratified Charge Rotary Engine
SDR	System Design Review
SEMP	Systems Engineering Management Plan
SLEP	Service Life Extension Program
SOW	Statement of Work
SRR	Systems Requirements Review
SSR	Software Specification Review
S/W	Software
SWS	Slow Water Speed
TACOM	Tank Automotive Command
T/E	Table of Equipment
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TIWG	Test Integration Working Group

TPM	Technical Performance Measurement
TQM	Total Quality Management
TRR	Test Requirements Review
UDLP	United Defense Limited Partnership
USC	United States Code
USD(A)	Under Secretary of Defense for Acquisition
WBS	Work Breakdown Structure

APPENDIX B. GLOSSARY OF TERMS

To alleviate reader confusion, definitions for terms not commonly used are provided alphabetically below. Whenever possible terms are defined accordingly to DoD standard terminology. For each term, the literature item (data source) providing the definition is cited.

Acquisition Category- Categories established to facilitate decentralized decision making and execution and compliance with statutorily imposed requirements. The categories determine the level of review, decision authority, and applicable procedures. (Department of Defense, Glossary: Defense Acquisition Acronyms and Terms, DSMC, Ft. Belvoir, VA., September, 1991.)

Amount at Stake- The extent of adverse consequences which could occur to the project. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Body of Knowledge- Encompasses the total population of published reference materials pertaining to a particular topic of interest. For this thesis the BOK relates to reference materials relating to the functional area of risk management. (Author.)

Cost Risk- The risk to a program in terms of overrunning the program cost. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

High Risk (Cost)- Scope of work and level of effort required are not well defined. The nature of the task to be performed differs significantly from previous tasks for which historical cost data exists. Historical cost data is unreliable, uncertain or incomplete and does not provide a good basis for estimation. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

High Risk (Schedule)- The scope of work and the effort required are not well defined. Therefore, the time required cannot be well defined. The schedule is very optimistic and can succeed only if all supporting and subordinate tasks can be completed on time. The schedule is dependent upon uncontrollable external events such as weather, or upon delivery of long lead time items for which the lead time is not well defined. The work package is on the critical path.

Delays in this area will impact the entire program. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

High Risk (Technical) - Requires the use of new materials, new production techniques, new components or new subsystem concepts previously undeveloped. The materials, techniques or components are not used in similar applications or only limited experience exists. Involves an area of technology which is not well known or well defined. Extrapolation from existing technology is uncertain and might cause program delays due to experimentation required to achieve success. Potential hazards may exist. Supply, repair, maintenance is not standard within U.S. military. Involves learning new skills or supplying items with little or no commonality to other systems; unique to AAAV. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Low Risk (Cost) - The work is well defined as to its scope and nature, and the level of effort required can be accurately estimated. The estimate is based on the contractor's response to a RFP or similar document. Historical cost data for similar tasks provides an excellent basis for estimation. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Low Risk (Schedule) - The work is well defined and routine in nature. There is little probability of unforeseen problems arising which would delay the schedule. The work is underway and on schedule. The work is on the critical path and adequate time exists to accommodate considerable slippage before it impacts the program. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Low Risk (Technical) - Involves the use of proven, existing components or subsystems whose characteristics are well known and documented. Any new design work required involves scaling or adapting the item to the application. Uses materials, production techniques and design concepts which are well known, tested, and proven. Involves an area of technology that is well known and documented. Component/item known to be safe with high reliability. Common on other vehicles. Not AAAV unique. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Moderate Risk (Cost)- Scope of work to be accomplished and level of effort required are reasonably well known. The nature of the task to be performed is similar to previous tasks for which good cost data exists. Historical cost data provides a reasonable basis for estimation. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Moderate Risk (Schedule)- The scope of work, and hence the time required, is reasonably well defined. The schedule allows sufficient time unless unforeseen difficulties arise. The work is underway, but is behind schedule. The work package is not on the critical path and some time exists which can be used for delays without affecting other elements of the program. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Moderate Risk (Technical)- Requires the use of new materials, new production techniques, a new component, or new subsystem not currently fielded in a combat vehicle or similar heavy off-road equipment concept. However, enough is known about the materials, techniques, components or concepts in question from laboratory and prototype testing or related applications, to provide reasonable assurance of achieving design goals. On-vehicle performance, reliability, and durability must be proven. Involves an area of technology not demonstrated at the required performance level. However, extrapolation from known data appears reasonable and should not involve a major technology breakthrough. Component not in the Marine Corps supply system, but is repairable with current skills levels. (U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the DRPM, Arlington, VA., October, 1994.)

Program Risk- The probability of not achieving a defined cost, schedule, or technical performance goal. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Programmatic Risk- The risks involved in obtaining and using applicable resources and activities that are outside of the programs control, but can affect the program's direction. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Project Risk Management- Is the art and science of identifying, assessing and responding to project risk throughout the life of a project and in the best interests of its objectives. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Quality Risk- Failure to complete tasks to the required level of technical or quality performance. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Risk- The condition of having outcomes with known probabilities of occurrence, not certainty of occurrence. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Risk Analysis- An examination of risk areas or events to determine options and the probable consequences for each event in the analysis. (Department of Defense, Glossary: Defense Acquisition Acronyms and Terms, DSMC, Ft. Belvoir, VA., September, 1991.)

Risk Assessment- The process of examining all aspects of a program with the goal of identifying areas of risk and the corresponding potential impact. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Risk Documentation- The formalized process of recording risk events and experience on past programs, preferably of a similar nature. (Author)

Risk Event- The precise description of what might happen to the detriment of the project. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Risk Handling- The action or inaction taken to address the risk issues identified and evaluated in the risk assessment and risk analysis efforts. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Risk Identification- The first step in the risk assessment process. It is the organized thorough approach to seek out the real risks associated with the program. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Risk Management- All actions taken to identify, assess, and eliminate or reduce risk to an acceptable level in selected areas (e.g., cost, schedule, technical, producibility, etc.); and the total program. (Under Secretary of Defense (Acquisition), DoD Instruction 5000.2 Defense Acquisition Management Policies and Procedures, Department of Defense, February 23, 1991.)

Risk Planning- Forcing organized purposeful thought to the subject of eliminating, minimizing, or containing the effects of undesirable occurrences. It allows for: 1) eliminating risk wherever possible; 2) isolating and minimizing risks; 3) developing alternative courses of action; and, 4) establishing time and money reserves to cover risks that can be avoided. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Risk Probability- The degree to which the risk event is likely to occur. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Risk Response- The actions taken by a program manager after confronted with a risk. (Author)

Schedule Risk- Failure to complete tasks within the estimated time limits, or risks associated with dependency network logic. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Scope Risk- Risks associated with changes of scope, or the subsequent need for "fixes" to achieve the required technical deliverables. ("Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.)

Simulation- A method for implementing a model. It is the process of conducting experiments with a model for the purpose of understanding the behavior of the system modeled under selected conditions or of evaluating various strategies for the operation of the system within the limits imposed by developmental or operational criteria. (Department of Defense, Glossary: Defense Acquisition Acronyms and Terms, DSMC, Ft. Belvoir, VA., September, 1991.)

Supportability Risk- The risks associated with fielding and maintaining systems which are currently being developed or have been developed and are being deployed. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Technical Risk- The risk associated with evolving a new design to provide a greater level of performance than previously demonstrated. Includes the same or lesser level of performance subject to new constraints such as size or weights. (Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.)

Uncertainty- A condition, event, outcome, or circumstance of which the extent, value, or consequence is not predictable. State of knowledge about outcomes in a decision which are such that it is not possible to assign probabilities in advance. Ignorance about the order of things. (Department of Defense, Glossary: Defense Acquisition Acronyms and Terms, DSMC, Ft. Belvoir, VA., September, 1991.)

APPENDIX C. DATA SOURCE MATRIX FOR RISK BOK

The following legend defines the risk content indicator coding scheme utilized in the following matrix:

1. "M" coded attributes denote a risk concept, task or process element which is mandatory/compulsory for the effected PM organization to accomplish, incorporate or adopt.

2. "R" coded attributes denote a risk concept, task or process element which is recommended or suggested for consideration, incorporation or adoption.

3. "S" coded attributes denote an risk concept, task or process element specified, described or defined in an informational context.

4. "I" coded attributes denote a risk concept, task or process element which was implied or inferred by the data source.

5. A "Blank" denotes no explicit nor implicit risk attribute coverage.

The below listed literature items represent thesis research data sources utilized and are portrayed in the same numerical sequence along the top horizontal margin of the following risk management BOK Data Source Matrix:

1. Office of Management and Budget, <u>OMB Circular A-109 Major Systems Acquisition</u>, Washington, D.C., April 5, 1976.

2. Department of Defense, <u>DoD Directive 5000.1 Defense Acquisition</u>, Under Secretary of Defense (Acquisition), February 23, 1991.

3. Department of Defense, <u>DoD Instruction 5000.2 Defense Acquisition Management Policies and Procedures</u>, Under Secretary of Defense (Acquisition), February 23, 1991.

4. Department of Defense, <u>DoD Manual 5000.2-M Defense Acquisition Management Documentation and Reports</u>, Under Secretary of Defense (Acquisition), February 23, 1991.

5. Department of Defense, <u>Military Standard-499B Systems Engineering</u>, May 6, 1992.

6. Department of Defense, Risk Management Concepts and Guidance, Defense Systems Management College, Ft. Belvoir, VA., March, 1989.

7. Department of Defense, Program Manager's Notebook, Defense Systems Management College, Ft. Belvoir, VA., June, 1992.

8. Department of Defense, Systems Engineering Management Guide, Defense Systems Management College, Ft. Belvoir, VA., January, 1990.

9. Department of Defense, Test and Evaluation Management Guide, Defense Systems Management College, Ft. Belvoir, VA., August, 1993.

10. Department of Defense, Integrated Logistics Support Guide, Defense Systems Management College, Ft. Belvoir, VA., May, 1986.

11. Department of Defense, Defense Manufacturing Management Guide, Defense Systems Management College, Ft. Belvoir, VA., April, 1989.

12. Department of Defense, Competitive Production Handbook, Defense Systems Management College, Ft. Belvoir, VA., August, 1984.

13. Department of Defense, Sub-Contracting Management Handbook, Defense Systems Management College, Ft. Belvoir, VA., May, 1988.

14. Department of Defense, Technology Transfer Guide, Defense Systems Management College, Ft. Belvoir, VA., November, 1988.

15. Department of Defense, Warranty Guidebook, Defense Systems Management College, Ft. Belvoir, VA., October, 1992.

16. Department of Defense, Mission Critical Computer Resources Management, Defense Systems Management College, Ft. Belvoir, VA., undated.

17. Department of Navy, Best Practices: How to Avoid Surprises in the World's Most Complicated Technical Process, NAVSO P-6071, March, 1986.

18. Department of Navy, Cost Realism Handbook, Navy Office for Acquisition Research, Washington, D.C., May, 1985.

19. U.S. General Accounting Office, "Technical Risk Assessment-The Status of Current DoD Efforts", GAO/PEMB-86-5, Washington, D.C., April, 1986.

20. Harp, D.M., A Management Case Analysis of the DoD Contractor Risk Assessment Program, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December, 1990.

21. Yosua, D.A., "Risk Management in Military Acquisition Projects", Military Project Management Handbook, Mc Graw-Hill, Inc., 1992.

22. "Project and Program Risk Management: A Guide to Managing Project Risks and Opportunities", Project Management Institute, Upper Darby, PA., 1992.

23. Boehm, B.W., "A Spiral Model of Software Development and Enhancement", Software Management, IEEE Computer Society Press, CA., 1993.

DATA SOURCE MATRIX

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
RISK DEFINITIONS																							
Distinction made between "risk" & "uncertainty"						S															S	S	
Acknowledgement of lack of uniformity & consistancy in definitions of terminology applied to risk management within DoD Pgms.						S															S		
Definitions provided for:																							
1. Risk						S	S														S	S	
2. Risk Facets						S	S																
-Technical						S	S										S				S		
-Supportability						S	S			R											S		
-Programmatic						S	S														S		
-Cost & Schedule						S	S														S		
3. Risk Management						S	S														S		
-Risk Planning						S	S														S		
-Risk Assessment						S	S										S				S	S	
-Risk Analysis						S	S											S			S		
-Risk Handling Techniques						S	S														S		
Types of risk:																							
1. Scope risk																						R	
2. Quality risk																						R	
3. Schedule risk																						R	
4. Cost risk																						R	
Sources of risk:																							
1. External, but unpredictable																						R	
2. External predictable, but uncertain																						R	
3. Internal, non-technical																						R	
4. Technical																						R	
5. Legal																						R	
Risk factors:																							
1. Risk event																					R	R	
2. Risk probability																					R	R	
3. Amount at stake																					R	R	

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
RISK MANAGEMENT CONCEPTS																							
Risk Mgmt is a proactive form of mgmt						R															R	R	I
Concept of risk mgmt not to be treated as separate function, but as integral part of overall program planning in PM office						R	R	R														R	I
Two perspectives of risk management:																							
1. Short term						R																	
2. Long term						R																	
Risk management is a 4 phase process:																							
1. Risk Identification						R																R	R
2. Risk Assessment						R																R	
3. Risk Response						R																R	
4. Risk Documentation						R																R	
Manage risks of the projects environ:																							
1. External influences																						R	
2. Interfaces																						R	
3. Project stakeholders																						R	
4. Public relations programs																						R	
RISK MANAGEMENT PLANNING																							
PM to establish risk mgmt plan	M	M	M	M		R	R	R		R			R				R	R			R		R
Risk mgmt. plan assessed ea MS Decision	M		M				R	R	R		R								R		R		R
5 step process in developing formal risk management plan:																							
1. Plan for risk management						R															R		R
2. Identify the known risks & prepare for the unknowns						R															R		R
3. Analyze the options						R															R		R
4. Make decisions based on long range benefits						R															R		
5. Update the planning						R															R		R
Risk management plan components:																							
1. Approach or process for risk mgmt.						R		R													R		R
2. Risk identification techniques						R		R													R		R
3. Focal points for risk mgmt.						R		R													R		R
4. Technique to be applied to risk mgmt.						R		R													R		R
5. Definitions						R		R													R		
6. Rating schemes	M			M	M	R		R			R								R	R	R		R
7. Frequency of analysis	M		M			R	R	I	R		R								R		R		R
8. Formats for reporting						R		R													R		

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PMs develop Risk Management Plan which consists of the following parts:																							
1. Description						R																	I
2. Program summary						R																	I
3. Approach to risk management						R																	I
4. Application						R																	I
5. Summary						R																	I
6. Bibliography						R																	I
7. Approval						R																	R
Components of risk mgmt plan includes:																							
1. Risk Planning	M					R	S	R													R		R
2. Risk Identification	M				M	R	S	R			R										R		R
3. Risk Assessment	M			M		R	S	R			R				R		S		R		R		R
4. Risk Analysis	M					R	S	R			R							R			R		R
5. Risk Reduction	M					R	S								R			R			R		R
Key elements of risk management by program phase:																							
Phase 0:																							
1. Assess manufacturing technical risks						R																	
2. Determine critical materials						R																	
3. Define contractual rqmts for Dem/Val						R																	
4. Evaluate manufacturing alternatives						R																	
5. Evaluate industrial base capability						R																	
6. Assess technical risks						R																	
Phase 1:																							
1. Evaluate competitive designs						R																	
2. Assess production level rqmts						R																	
3. Determine contractual rqmts						R																	
4. Establish readiness objectives						R																	
5. Evaluate technical risks						R																	
6. Develop testing concepts						R																	
7. Develop measuring metrics						R																	
Cross reference to DoD 4245.7-M made	M					R	R	R	R	R							R				R		

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
RISK IDENTIFICATION																							
Techniques to gain information relating to risk:																							
1. Common sources of subjective info.																							
-Expert interviews						R	R														R		R
-Independent technical assessments						R	R														R		
2. Common sources of objective info.						R	R	R													R		R
-PMP,SEMP,Acq.Plan,TEMP,ILSP, WBS, Manuf. Plan, SOW, Specs, schedules, cost estimates, contractual documentation, contractor C/SCSC, test data																							
PMs conduct in house design reviews to identify risks being taken through the various technical approaches in a program								R															R
RISK ASSESSMENT																							
Biases in the risk assessment process																					S		
Sources available upon which to assess risk:																							
1. Lessons learned on similar programs						R	R	R													R	.	R
2. Expert interviews & studies						R	R														R		R
3. Review of baseline cost estimates						R	R	R										R			R		
4. Evaluation of program plans & docs. (ex; PMP, SEMP, TEMP, Man. Plan, IPS, ILSP, WBS, Specs, SOW)					M	R	R	R	R	R											R		R
5. Transition Templates DoD 4245.7-M						R	R	R	R	R							R				R		
6. Technology Assessment						R	R														I		
7. Contractor risk assessment					M	R	R	R									R	R		R	R		
Techniques to improve technical risk assessment concepts & procedures:																							
1. Define tech. risk & categories for rating risk:					M	R		R											R		R		
2. Require risk efforts explicitly focus on technical risk, be prospective, planned & repeated at least twice a year, early & late in each acquisition phase						R													R				
3. PMs document risk assessment procedures & results						R		R											R		R	R	

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
4. Establish guidelines regarding options for format for rating risks, scope, data collection, sources of risk info. & assessment approaches						R		R											R		R		
5. Provide focused training in technical risk assessment						R													R				
Risk Baseline for risk assessment						R																R	
System engineering tools applicable to risk assessment & handling:																							
1. TPM								R															
2. LCC								R															
3. CM								R															
4. Templates								R															
5. Trade-off analysis								R															
RISK ANALYSIS																							
Use of multi-disciplinary teams to examine risk areas						R	R			R													R
Have clearly defined risk evaluation criteria for assigning risk ratings of low, moderate & high, for each major subsystem & the overall system	M			M	M	R		R			R								R	R			
Risk quantification methods:																							
1. Risk scoring/rating						R		R													R		R
2. Probabilistic distributions						R		R													R	R	
Use of WBS to identify & analyze risk						R	R	R		R											R		
Risk analysis methods:																							
1. Problem structuring																						R	
2. Risk identification/screening																						R	R
3. Risk quantification																						R	
4. Risk modeling																						R	
5. Overall economic modeling																						R	
6. Project risk report																						R	
7. Brainstorming						R																R	
8. Sensitivity analysis						R																R	
9. Probability analysis						R																R	

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
10. Delphi method						R																R	
11. Monte Carlo						R																R	
12. Decision tree analysis						R																R	
13. Utility theory						R																R	
14. Decision theory						R																R	
15. PERT						R																R	
Analysis techniques/tools for cost, schedule & performance risks:																							
1. Network analysis						R		R													R	R	
2. Decision trees/analysis						R		R													R	R	
3. Performance tracking						R		R													R		
4. AHP								R													R	R	
5. Watch lists-Top ten list						R		R													R		R
Examples of risk analysis methods:																							
1. Subjective Analysis						R	R														R		
2. FMECA						R	R			R													
3. Human Factors Analysis							R																
4. Hazard Analysis							R																
5. Simulations						R	R	R	R												R		R
6. Network Models						R	R	R													R		
7. LCC models						R	R	R		R											R		
8. Quick Reaction Model							R	R															
Expected Monetary Model for decision analysis						R																	
Conduct trade studies								R							R								
RISK DOCUMENTATION																							
User participation in risk documentation & analysis process	M						R	R		R													R
Risk monitoring & reporting in 5 major categories:																							
1. Design (performance)								R															
2. Test								R															
3. Production								R															
4. Cost								R															
5. Management								R															
PM create a technical risk dictionary						R																	
Develop historical databases, current databases, post-project review & archive database to document risk																						R	
Top & lower level risk matrix						R																	

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PM "Watch List" to monitor & control risk						R	R	R													R		R
Automated Program Planning Documentation Model (APPDM) w/ Risk Mngt Plan element						R																	
PMP & SEMP provide definitions for risk management terms applied to program								R													S		
IPS Risk Assessment format:				M			R																
1. Threat																							
2. Technology																							
3. Design & Engineering										R													
-H/W															R								
-S/W															R								
4. Manufacturing											R												
5. Support																							
6. Cost																							
-Funding																							
7. Schedule																							
-Concurrency																							
RISK MITIGATION																							
Risk Handling technique categories:																							
1. Risk Avoidance					M	R	S	R													R	R	
2. Risk Controlling					M	R	S	R													R		
3. Risk Assumption					M	R	S	R													R	R	
4. Risk Transfer						R	S	R													R		
5. Combinations of above						R		R													R	R	
Risk Control activities:																							
1. Subsystem PDR							R				R												
2. Internal contractor reviews					M	R	R	R									R			R			
3. Design review & drawing release procedures at prime contractor					M		R										R						
4. Analysis of risk areas					M	R	R	R			R							R		R			
5. Simulations						R	R	R	R											R			R
6. Component & full scale tests							R	R	R														
7. Multi disciplinary approach to challenging design & assessing risk						R	R																
8. Event-driven design reviews vice calendar-driven							R																
9. Use of mock-ups							R																
10. Logistics & maintainability demonstrations						R	R			R	R												

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
11. Failure reporting & analysis						R	R																
12. Reviews: SRR, SDR, SSR, PDR, CDR, TRR, PRR, FCA, FQR, PCA							R	R			R												
13. Plans & Documents: PMP, SEMP, RMP, TEMP, MP, ILSP, CMP, WBS, Specs, SOW, Cost reviews, IOT&E, Communication					M	R	R	R	R												R		R
For Phase's 0 & 1, manufacturing & producibility issues associated w/design concept & manufacturing process. Production risk & efforts to reduce them.	M					R					R									R			
Use of CRAG program by contractor to reduce risk																				R			
RISK AREAS																							
Risk areas to be explicitly assessed at MS decision points:																							
1. Threat, technology, design & engineering, support, manufacturing, cost & schedule			M	M			R			R													
2. Risks inherent in the degree of concurrency being proposed			M																				
Most common risk situations observed						S																S	
Definition of technical risk traps:																							
1. Contractor claims to have tech. risk assessment & reporting system																	S						
2. Project design, test & manufacturing engineers know the tech. problems																	S						
3. Top level rqmts. contained in end item specs.																	S						
4. Develop. & manuf. test results are good tech. risk indicators																	S						
Definition of benefits, escapes, alarms & consequences to above traps								R									S						
Escapes defined for each trap:																							
Escape 1: Contractor augment C/SCSC w/tech. risk assessment system					M	R											R				R		
Escape 2: Provide formal reports to all levels of mgmt. on tech. status, probs., corrective actions & impact																	R				R		

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Escape 3: Ensure allocation of top level rqmts to all levels of design & test																	R						
Escape 4: Develop a comprehensive list of tech. risk indicators from design & test activities, for risk mgmt. during EMD & early production						R			R	R							R				R		
Technical risk assessment checklist corresponding to escapes above																	R						
Subclassifications of major sources of risk						S															S		
Specific project risks																						S	
ACQUISITION STRATEGY CONCERNS																							
Alternative/evolutionary acquisition strategies for systems where rqmts. refinements are anticipated of where tech. risk or opportunity discourages implementation of rqd. capability	R																						
Identifies acquisition streamlining as cause of loss of standardization										S													
Maintaining multiple alternatives in high risk areas	R										R	R											
Tailoring of # of phases & decision points to meet need of individual program	M	M								R													R
Tailoring based upon risks & adequacy of risk management plan	M									R					R					R			R
DEVELOPMENT/DESIGN CONCERNS																							
Accelerated system development delays design maturation causing numerous configuration changes later in program										S													
SOFTWARE CONSIDERATIONS																							
S/W risk areas:																							
1. Compiler maturity																R							
2. Availability & maturity of S/W support tools																R							
3. Loosely defined or incomplete interface definitions																R							
4. Lack of adequate computer memory or throughput capability																R							

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Management techniques to reduce risks:																							
1. Rapid prototyping																R							R
2. Incremental development																R							
3. Internal (Gov't) program reviews (at least monthly)																R							R
4. Top Ten list review																R							R
5. Early demonstrations & testing of risk items																R							R
6. Gov't inspections & audits of S/W development process																R							
Systems rqmts analysis activities for C/E & Dem Val:																							
1. Determine overall project rqmts																R							
2. Determine project feasibility																R							
3. Develop acquisition strategy																R							
4. Establish resource cost & schedule																R							
5. Define the interrelationships between H/W & S/W																R							
6. Define technical & business functions & performance																R							
Finalize system level requirements through engineering studies & trade-off analysis' incl:																							
1. Requirements refined																R							
2. Operational Concept Analysis																R							
3. Trade-off & optimization																R							
4. Evaluate risks associated w/computer resources																R							
Generate "A" specification to incorporate system level requirements for S/W																R							R
RFP specify for contractor to address method used for risk control																R							
S/W risk management as a separate mgmt. discipline																							S
Risk driven approach vice document driven approach																							R
Primary functions of S/W process model are to determine the "order of the stages" involved in the development & evolution & to establish the "transition criteria" for progressing from one stage to another																							R

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
S/W process model incorporates completion criteria for current stage plus choice criteria & entrance criteria for the next stage																							R
S/W process model identify sources of risk																							R
S/W process model formulate risk resolving strategy																							R
S/W process model risk resolving techniques:																							R
1. Prototyping																							R
2. Simulation																							R
3. Benchmarking																							R
4. Reference checking																							R
5. Administering user questionnaires																							R
6. Analytic modeling																							R
7. Combinations of the above & other risk reducing techniques																							R
Joint involvement of user & developer in reviewing program status, products, plans for next stage																							R
Applicability of "Spiral Model" to development as well as, enhancement effort																							S
Risk driven documents such as; specifications & plans for risk evaluation																							R
Elimination of unattractive alternatives early & inexpensively in program acquisition cycle																							R
S/W risk mgmt process components:																							R
1. Risk Identification																							R
2. Risk Analysis																							R
3. Risk Priortization																							R
4. Risk Management Planning																							R
5. Risk Element Tracking																							R
Top Ten List of S/W risk items to monitor & control																							R
S/W Risk Management Plan components:																							R
1. Identify projects top ten risk items																							R
2. Present a plan for resolving each risk item																							R
3. Update list of top risk items, plan, & review results monthly.																							R

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
4. Highlight risk item status in monthly project reviews. Compare w/previous months rankings, status.																							R
5. Initiate appropriate corrective action.																							R
Risk assessment training for program management personnel																							I
Tailoring of acquisition strategy based upon risk plan																							R
PROTOTYPING/TECH. DEMONSTRATION																							
Technology demonstrations & aggressive prototyping (including manufactoring processes, H/W & S/W systems, & critical subsystems), coupled w/EOA's	M		M				R				R												R
Competitive prototyping of critical systems	R											R											R
TESTING CONSIDERATIONS																							
T&E to determine system maturity & identify areas of technical risk		M	M				R		R	R					R						R		
Realistic T&E of parts, components, subsystems, & systems to estimate & manage technical risk								R	R	R	R												
Weapon system testing checklist for phase O:																							
1. Prepare test plans which include detailed evaluation criteria for all items to be tested									R														
2. Validation test plans to evaluate performance characteristics									R														
3. Performance characteristics range									R														
4. Operating degradation									R														
5. Test personnel									R														
6. Design reviews									R														
7. Surrogate vehicles when high tech risk is present									R														
8. Test facilities & scheduling									R														
T&E contributions during phase 0:																							
1. Lab testing, modeling & simulation conducted by contractor & development agency to demonstrate & assess the capabilities of key subsystems & components									R		R												

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2. Test & simulation designs based on rqmts in Mission Need Statement									R	R													
3. Studies, simulations, analyses & test data used by develop agency to explore & evaluate alternative concepts proposed to satisfy rqmts									R														
4. OT agency monitors concept exploration T&E to gather info for future T&E planning. OTA also performs OA's									R														
5. At end of phase 0, the development agency prepares the DT&E system concept report which is incorporated into IPS									R														
T&E contributions during phase 1:																							
1. D,T&E of components, subsystems & prototype development models									R		R												
2. D,T&E to ensure engineering is complete (including; all ...ilities)									R	R	R												
3. Service OT&E agency conduct EOA's									R														
4. Develop. agency prepares report on results of Dem/Val D,T&E for review by service headquarters									R														
T&E contributions listed for Ph 2, 3, & 4									R														
Combining DT & OT	R																						
MANUFACTURING CONSIDERATIONS																							
Definition of Manufacturing Risk Assessment											S												
Categories of manufacturing processes & materials:																							
1. State of the practice											S												
2. State of the art								R			S	I											
3. Experimental											S												
Demonstrate use of experimental material in factory prior to manufacturing environment	M		M				R				R	R											
CONTRACTING CONSIDERATIONS																							
Degree of risk vs contract type																					S	S	
Contract type permit equitable & sensible allocation of risk between Gov't & industry			M			R															R	R	

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Considerations in selection of contractual approach:																							
1. Degree of work definition																					R		
2. Product resulting from contract																					R		
3. Complexity of contract																					R		
4. Performance period																					R		
5. Extent of competition																					R		
6. Urgency of requirement																					R		
7. Overall degree of cost, schedule, technical uncertainty																					R		
Early competitive award as risk reduction technique												R											
RFP contain data items:																							
1. Risk Mgmt Plan						R																	
2. Risk Assessment Report						R																	
Composition of contractors offer:																							
1. Engineering/design																			R				
2. Reliability and Maintainability																			R				
3. Producibility																			R				
4. Quality in design																			R				
5. Manufacturing research/technology																			R				
6. Project Control System																			R				
7. Quality Assurance																			R				
8. Security																			R				
Contractors identify risks & specify plans to assess/eliminate risks or reduce them to acceptable levels	M	M	M		M	R	R	R		R	R		R				R	R		R			
Contractor risk documentation:																							
1. Risk Management Program Plan for C/E & updated at each phase								R															
2. Risk Sensitivity Analysis								R															
3. Risk Handling Plans								R															
4. Risk Reduction Reports								R															
Actions to minimize impact of lead time variations:																							
1. Encourage design stability										R	R												
2. Investigate advance procurement funding possibilities											R												
3. Consider multi-year procurements	R										R												

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
4. Consider COTS subsystems											R												
5. Ensure compliance w/DoD priority system.											R												
6. Evaluate spec. needs. Consider subs. for components & materials w/long lead times.											R												
7. Consider combined procurement of end items, spares & repair parts.											R												
Risk associated w/ technology transfer effort if the second source fails to qualify for production in timely manner. Activities to mitigate this risk:																							
1. Provision of additional tech. support														R									
2. Provision of material support including; GFE & assistance in tooling & test equipment development														R									
Dual sourcing evaluation	R											R		R									
Multi-year procurements	R										R												
Increase Gov't attention to sub-contractor activities as risk reduction method													R										
SCHEDULE CONSIDERATIONS																							
Schedule subject of trade-off as a method of minimizing risk		M	M				R																
PM employ network schedule to identify deployment activities						R				R											R		
COST/BUDGETING CONSIDERATIONS																							
Critical parameters that are cost drivers or have significant impact on readiness, and LCC identified early & managed intensively	M		M		M		R	R		R											R		
Gov't budget for risk through the use of "management reserve"																		R				R	
Analysis techniques/tools for cost risks:																							
1. Risk factors						R		R													R	R	
2. Estimating relationships						R		R													R	R	
3. WBS simulation (Monte Carlo simulation)						R		R													R	R	
4. Influence diagrams								R													R		
5. Methods of moments								R													R		
6. Multi attribute utility modeling								R													R		

DATA SOURCE ATTRIBUTE	DATA SOURCE																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
7. LCC modeling						R		R													R		
8. CPR analysis						R		R													R		
LOGISTICS CONSIDERATIONS																							
Use LSA during phase 0										R													
Develop spares acquisition strategy early in EMD										R													
Ensure facilities planning is accompl.						R				R											R		
ILSP incorporate PPS										R											R		
WARRANTY CONSIDERATIONS																							
Integrate warranty considerations into acquisition strategy								R			R				R								
Warranty risks															R								

APPENDIX D. DATA SOURCE MATRIX FOR AAAV PROGRAM

The following legend defines the risk content indicator coding scheme utilized:

1. "A" coded attributes denote a risk management concept, task, strategy or technique which has been applied within the AAAV program.

2. "O" coded attributes denote a risk management concept, task, strategy or technique which is on-going within the AAAV program.

3. "P" coded attributes denote a risk management concept, task, strategy or technique which has been identified for future application within the AAAV program.

4. "R" coded attributes denote a risk management concept, task, strategy or technique which has been recommended for application within the AAAV program.

5. "*" coded attributes denote a risk management concept, task, strategy or technique which has been applied, is ongoing and is planned for continued application within the AAAV program.

6. "S" coded attributes denote a risk management concept, task, strategy, technique, or condition which has been specified as effecting the AAAV program.

7. A "Blank" denotes no explicit nor implicit risk attribute coverage.

The below listed literature items represent thesis research data sources utilized and are portrayed in the same numerical sequence along the top horizontal margin of the following Data Source Matrix for the AAAV Program:

1. U.S. Marine Corps, Operational Requirements Document (ORD) for the Advanced Amphibious Assault Vehicle (AAAV), C.G. MCCDC, Quantico, VA., March 24, 1994.

2. U.S. Marine Corps, Advanced Amphibious Assault Vehicle (AAAV) Program Integrated Program Summary (IPS), Office of the Direct Reporting Program Manager, Arlington, VA., October, 1994.

3. U.S. Marine Corps, Test and Evaluation Master Plan for the Advanced Amphibious Assault Vehicle (AAAV) Program, Office of the Direct Reporting Program Manager, Arlington, VA., July 8, 1994.

4. U.S. Marine Corps, System/Segment Specification (Type "A" Spec.) for the Advanced Amphibious Assault Vehicle (AAAV) Program, Office of the Direct Reporting Program Manager, Arlington, VA., August, 1994.

5. U.S. Marine Corps, Human System Integration (HSI) Plan for the Advanced Amphibious Assault Vehicle (AAAV) Program, Office of the Direct Reporting Program Manager, Arlington, VA., March 8, 1994.

6. Department of Navy, Technical Assessment, Advanced Amphibious Assault Vehicle (AAAV) Updated Concepts, Office of Advanced Technology, Chief of Naval Research, Washington, D.C., November 15, 1992.

7. Center for Naval Analysis, Advanced Amphibious Assault (AAA) Program Cost and Operational Effectiveness Analysis (COEA): Ship-to-Shore Analysis, Alexandria, VA., July, 1990.

8. Center for Naval Analysis, Life Cycle Costs of Advanced Amphibious Assault System Candidates, Alexandria, VA., January, 1991.

9. Center for Naval Analysis, Revised Life Cycle Costs for Advanced Amphibious Assault System Candidates, Alexandria, VA., April, 1991.

10. U.S. Marine Corps, An Opportunity for Change: A Briefing for the Commandant of the Marine Corps, Office of the Direct Reporting Program Manager, Arlington, VA., June, 1993.

11. U.S. Marine Corps, "Commandant of the Marine Corps' AAA Article", AAV-AAA Requirements Office, MCCDC, Quantico, VA., September, 1993.

12. Department of Defense, Audit Report: Acquisition of Advanced Amphibious Assault Vehicles, Rpt.No. 93-116, DoD Inspector General, Washington, D.C., June 18, 1993.

13. Department of Defense, FY-94 Integrated Priority List (IPL) Administrative Guidelines, Defense Simulation and Modeling Office (DMSO), Washington, D.C., 1994.

14. Holzer, Robert., "Testing Simulation's Worth", Navy Times, January 24, 1994.

15. Robertson, B.J., "From Ship to Shore-And Well Beyond", Armed Forces Journal, September, 1994.

16. Corcoran, Michael. A., An Evaluation of Competitive Procurement Methodologies Applicable to the AAA Program, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December, 1988.

17. Clark, James. W., Acquisition Streamlining: A Viable Method for Accelerating Procurement of the AAAV, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December, 1993.

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RISK DEFINITIONS																	
Risk definitions provided		A				A											
RISK MANAGEMENT PLANNING																	
DRPM establish risk management plan.						A											
Risk management plan provide activities to be assessed at each MS.						*											
DRPM conduct in–process review w/ contractor to determine likelihood of delivering engine on time.		P				P											R
RISK ASSESSMENT																	
Program risk areas capable of being evaluated by risk assessment procedures:																	
1. Basic & applied Research & Exploration												R					
2. Advanced & engineering development												R					
3. Testing												R					
4. Milestone decisions												R					
5. Acquisition strategy												R					
6. Contract administration												R					
7. Procurement												R					
8. Financial management												R					
Risk assessments performed on:																	
1. Stratified Charge Rotary engine		A				A						A					
2. AAA Program		A				A						A					
3. FMS		A				A						A					

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RISK ANALYSIS																	
DRPM establish Internal Management Control Plan for assessing and rating risks (high, medium, low).												R					
DRPM to use FMECA, LCC Estimates & Level of Repair Analysis during D&V to assist in development & maturation of detailed maint. plan which will be cost effective & consistent with mission requirements.		P		P													
Monte Carlo simulation to perform risk analysis in the LCCE.		A															
RISK DOCUMENTATION																	
Involve customer early in process.			P		P												R
Use of O&M personnel from FMF units at contractor facilities to comment on & assess technical, safety, training, maintenance, & human factors issues of the designs.			A														
All of the analyses, tech data, test results & H/W configurations entered into the DTIC data base.											A						
RISK MITIGATION																	
The AAAV program employed an aggressive & highly focused technology base program.		A				A					A						

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
AAAV program was directed to aggressively pursue technical risk reducing activities by Navy Acquisition Executive during CE/D. All significant technical risk reducing projects have been formally reviewed and favorably endorsed by the Office of Chief of Naval Research.		A	A	A		A					A				A		A
The AAAV Tech. Base program targeted high risk drivers of affordability, performance & the known core requirements of a high water speed amphibian for early development & for the purpose of physically demonstrating the feasibility of high water speed amphibious vehicles before embarking on a AAAV program.		A				A				A	A				A		
PSD demonstrated on Potomac River in Washington D.C. for the CMC, ACMC, CG MCDCC, members of Marine Corps General Staff, representatives of the OSD, representatives of the Sec. of the Navy, Congressional Staff members & the media.											A				A		
Tech base program used as springboard for more detailed development work during CE/D.											A				A		
Risk reducing experiments conducted by AAAV program office with their actual conceptual designs. These were in addition to normal contractor CE/D activities. These include:																	
1. Tow tank model tests		A	A	A		A				A	A				A		
2. Water propulsion		A	A	A		A				A	A				A		
3. Electric drive		A	A	A		A				A	A				A		

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
4. Full scale vehicle mock ups		A	A	A		A				A	A				A		
5. Live fire armor ballistic tests		A	A	A		A				A	A				A		
6. Armor repairability tests		A	A	A		A				A	A				A		
7. 2 FMF EOA's		A	A	A		A				A	A				A		
8. Appendage Actuation/Robustness tests		A	A	A		A				A	A				A		
9. Construction/testing of contractor .75 & .80 scale HWS hydrodynamic test rigs		A	A	A		A				A	A				A		
As part of Continuing Engineering efforts during the CE/D phase, each contractor was given opportunity to propose & conduct risk reducing experiments of key technology areas for their concept. The results of these efforts were or will be applied to the system design.		A	A			A											
Risk reducing efforts accomplished to address risk areas:																	
1. Contractor reviewed, validated & updated vehicle weight estimates.						A											
2. GDLS updated their planing hull concept design to eliminate high risk components.						A											
3. Use of independent contractor to assess risks of primary diesel engine candidates.						A											
4. Engineering analyses by contractors.						A											
5. Risk reducing experiments.						A											
AAAV contractors risk reducing activities will center around the building & testing of Full Scale Automotive (LAND) test rigs prior to the D&V phase contract award.		P	P	P		P					P				P		P

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RISK AREAS																	
Principal risk areas identified, categorized and rated.		A				A											
Principal risk areas:																	
1. High water speed ability.		S				S											
2. Appendage robustness.		S				S											
3. Design integration.		S				S											
Technical risks within program:																	
1. Overall– medium.		S				S				S							
2. Completion of engine development is risk pacing item.		P				P				P							S
3. Weight control and systems integration.		P				P				P							
4. Operational requirements "scrub" key to technical risk control.		P				P				P							
Cost risks within program:																	
1. Overall– low to medium.		S				S				S							
2. Due primarily to uncertainties associated with Phase 0.		S				S				S							
ACQUISITION STRATEGY																	
AAAV program office at MS I review obtain permission to engage in engineering & manufacturing development activities during the course of Phase I of the acquisition process.																	R
"Component breakout" and "design to cost" to encourage development of competition at the subcontractor level & reduce risk.		P														R	

DATA SOURCE ATTRIBUTE	DATA SOURCE 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Acquisition activities for D&V Phase:																	
1. Down select & require the single contractor to build & demonstrate one pre-production prototype of the AAAV(P).		P	P	P													
2. A stationary mock up of the AAAV(C) will be built along with reconfigured ATR.		P	P	P													
3. A ballistically configured hull & turret will be constructed for preliminary live fire survivability testing.		P	P	P													
4. EOA on the prototype.		P	P	P													
5. A Corrective Action Review Team (CART) formed by the DRPM.		P	P	P													
6. Members of the Test Integration Working Group (TIWG) participate on CART.		P	P	P													
7. DT-I & EOA's.		P	P	P													
Acquisition activities for EMD Phase:																	
1. Contractor build six production representative vehicles for testing.		P	P	P													
2. DT-II & IOT&E.		P	P	P													
3. LRIP decision at MS II.		P	P	P													
4. First Article Testing (FAT) on first two LRIP vehicles.		P	P	P													
5. LFT&E on two EMD pre-production vehicles.		P	P	P													
6. IOC.		P	P	P													
Acquisition activities for FRP Phase:																	
1. FOT&E & Initial Production Testing (IPT) conducted concurrently with LRIP & production build-up.		P	P	P													

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2. FOT&E & IPT conducted to re–work and re–test problems identified but not corrected during DT II & IOT&E & to validate necessary H/W systems built on full–production tooling.		P	P	P													
3. FOC.		P	P	P													
AAAV program to use a evolutionary acquisition strategy within a streamlined defense acquisition model. (AKA; Paradigm shift model).		P								P	P						P
Acquisition strategy target "core" requirements or the most essential attributes of the system to ensure earliest fielding.										A	P						P
Paradigm shift model seeks to field a required system as soon as the major core operational capabilities are reached.										P	P						P
Paradigm shift model incorporates:																	
1. Sponsorship at the highest levels. (IE; Sec Def., Dep Sec Def., USDA.)										P	P						
2. Streamlined decision making.										P	P						
3. Program stability.										P	P						
Paradigm shift model to overcome:																	
1. Current DoD oversight & auditing practices.		P								P	P						
2. Military unique specifications, processes, standards, tech data requirements.		P								P	P						
3. Unique gov't cost accounting & pricing requirements that increase program schedule & interrupts & delays program progress.		P								P	P						

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Paradigm shift model to eliminate artificial phases & milestones currently mandated by DoD 5000 directives.		P								P	P						P
Departure from typical acquisition cycle can be achieved by deleting EMD, Phase II and by accomplishing acquisition activities earlier.		P															R
Down select to one contractor to occur shortly after MS I review.		P	P	P		P											R
DEVELOPMENT AND DESIGN																	
Use of common subsystems/components in all AAAV mission role variants to the maximum practical extent.	P	P	P	P													
Plan for future upgrades early in acquisition process.		P															R
System design to design in space, weight, power claims, channels, hard points, ect. to incorporate leap ahead, mature proven technologies infused from the DoD Science & Technology Thrust Areas.		P		A		R					P						
Application of "open architecture" & partitioned design to allow for significant growth or complete change out of sub-systems prone to rapid evolution (S/W, weapon system) or those that represent critical risk (propulsion system).		A															
DRPM to establish the development & in-service margins for the AAAV.						R											
Contractors to perform concurrent engineering.					P						P						R

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Use of multi–disciplinary teams, computer aided tools & other system engineering tools by contractors to apply concept of concurrent engineering in development & production.					P												R
As the design of the AAAV stabilizes the DRPM take steps to tighten estimates of facilitization cost & quantity of vehicles to be produced																R	
Use of Marines & Gov't engineers on the contractors development team.					P												R
DRPM office to utilize or coordinate with expert resources at U.S. Army Tank Automotive Command (TACOM) specifically to land mobility and survivability to assist in conceptual design of the AAAV.												R					
Use of available Off–the–Shelf or low–developmental computer H/W components that have been ruggedized whenever possible.	P																
PROTOTYPING & TECHNOLOGY DEMONSTRATION																	
Advanced technologies developed for every vehicle subsystem.			A	A		A					A						
Subsystems were systematically integrated & tested in series of successively more complex operational demonstrators including a .55 scale HWS model, & a .75 scale propulsion systems demonstrator (PSD).		A	A	A		A					A				A		A
DRPM requested exception be granted to the competitive prototyping rqmts of Title 10, U.S.C., Sec 2438, "Major Programs, Competitive Prototyping".		A															

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Full scale prototype development & test of the HWS vehicles necessary to resolve principal areas of risk.		P				R											
Fabrication & testing of sub-scale components to allow more refined concepts be incorporated into Dem Val detailed design effort w/less risk.		A	A			A											
Use of ATR's as risk reducing activity to identify high risk drivers & evaluate first generation AAAV track & suspension units components.		P	P			P											
Contractors to produce prototypes early in acquisition process.		P	P			P					P					P	P
Use Dem Val prototype to reduce program risk through determination of technical deficiencies in sub-systems & operational modes that will be corrected in EMD.		P	P														
TESTING																	
Ballistic testing of contractor submitted armor samples.		*	*			*											
Lessons learned from previous LFT&E on combat vehicles will be utilized in testing issues, set-up, and analysis.			P														
Use of private testing laboratories & facilities if scheduling conflicts arise or cost or schedule savings to Gov't can be realized.			P														
Concurrent DT & OT will be investigated where feasible & practical. Opportunities may exist for concurrent DT & OT testing at remote locations.			P														

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Verification of previous modelling done for the COEA will be accomplished with actual vehicle test data from DT–I/II, EOA's & OT&E.			P														
To maximum extent possible, built–in–test & built–in–test equipment will be incorporated into system design to reduce troubleshooting tasks.	P			S													
Test & Evaluation events:																	
General																	
With exception of water testing during DemVal, AAAV testing will follow a classical acquisition approach w/dedicated & separate testing for DT&E & OT&E.		P	P	P													
Development Testing (DT)																	
1. Identify potential operational & technological limitations of design options.		P	P	P													
2. Support identification of cost–performance trade–offs.		P	P	P													
3. Support identification & description of design risks.		P	P	P													
4. Substantiate that contract tech. performance & manufacturing process rqmts have been achieved.		P	P	P													
5. Support decision to certify system ready for OT&E.		P	P	P													
First Article Testing (FAT)																	
1. Includes preproduction & initial production testing to ensure contractor can furnish product that meets ORD rqmts & A Spec		P	P	P													

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Physical Teardown & Logistics Demonstration (PLTD)																	
1. Part of PCA to verify configuration as built conforms to tech documentation.		P	P	P													
2. PLTD performed concurrent with the initial LRIP item(s) acceptance.		P	P	P													
Live Fire Test & Evaluation (LFT&E)																	
1. Ballistic tests & armor qualification conducted during Dem Val. Live fire & ballistic testing conducted during EMD.		P	P	P													
Operational Testing (OT)																	
1. OT−I concurrently w/DT−I.		P	P	P													
2. EOA's for mock−up AAAV(C) & ATR.		P	P	P													
Initial Operational Test & Evaluation (IOT&E)																	
1. Conducted on LRIP vehicles.		P	P	P													
Follow On Test & Evaluation (FOT&E)																	
1. Conducted during & after production period to refine estimates made during OT&E.		P	P	P													
Contractor Tests																	
1. Inspections		P	P	P													
2. Analysis.		P	P	P													
3. Demonstration−uninstrumented.		P	P	P													
4. Instrumented tests.		P	P	P													
MODELING & SIMULATION																	
Potential for development & use of models in addition to those used in COEA in order to encompass OMFTS tactics as they evolve over the next several years.			P														

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Contractors to make extensive use of advanced computer modeling & simulation.		P	P		P						P						R
Use of AAAV program as test case for M&S with lessons learned to be shared with other military services.														P			
DMSO provided $1.4 million to AAAV program office to study three M&S objectives:			A										A	A			
1. What can modeling & simulation bring to the AAAV acquisition process?			O										O	O			
2. Will M&S technology produce cost savings for the AAAV acquisition program?			O										O	O			
3. Can simulation systems bought for testing also be used for training?			O										O	O			
SYSTEMS INTEGRATION																	
AAAV program will use DoD HSI methodology to determine Manpower, Personnel, Training, Human Factors Engineering, Safety & Health Hazards rqmts.	P			S	P							R					
An objective of HSI program will be to reduce manpower rqmts for operators & maintainers below that currently required for the AAV7A1.	P			S	P							R					
The HSI program has been designated by the DRPM/AAAV as a risk management initiative.					*							R					

DATA SOURCE ATTRIBUTE	DATA SOURCE																
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Limited operational effectiveness, costly modifications, & understated cost estimates could result if human factors for environmental cooling systems for the crew and passengers are omitted from the concept design of the AAAV.												S					
CONTRACT MANAGEMENT																	
DRPM to ensure competition on the support service contracts with respect to prime, as well as, subcontractor service contractors.												R					
Use of contractor teaming early in AAAV program acquisition process to minimize risk associated with developing production competition.																R	
DRPM office maintain liaison w/other program offices employing contractor teaming strategy.																R	
COST AND BUDGETING																	
Leading cost drivers identified.		A				A											
Trade–off analyses involving cost drivers performed.		A				A											
Cost/performance trade–offs to evaluate NDI v.s. newly developed/emerging systems.		*															
Anticipated R&D & procurement $ needs are beyond the DoN's level of affordability.										S							

DATA SOURCE ATTRIBUTE	DATA SOURCE																
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LOGISTICS MANAGEMENT																	
Logistics support & maintenance for the AAAV to be performed w/i existing USMC logistic support organizational structures.	P			S													
Supply planning will be closely coordinated w/ maintenance planning during all phases of AAAV development to ensure timely availability of supplies to meet provisioning & replenishment rqmts from IOC through FOC.	P			S													
Incorporate maintainability & LCC concerns into system design to ensure ease of maintenance & accessability of assemblies/ subassemblies.	*			S	P												
Maintenance concept– "Fix as far forward as possible" to drive maintenance costs down & increase availability.	P		S	P													
Transfer of current communication & navigational equipment from AAV7A1 to AAAV when fielded to reduce acquisition needs & risks. These components are NDI & are expected to fulfill the necessary rqmts.			P														
Use of DT–I testing to initially assess maintainability & logistics supportability.			P														
Maximum use of existing support equipment in lieu of special purpose equipment is required where feasible.	P			S													
Organizational tools kept to a minimum.	P			S	P												

DATA SOURCE ATTRIBUTE	DATA SOURCE																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Use of LSA & level of repair analysis programs to validate AAAV provisioning objective. Will continue through full–rate production & deployment phase.	P			S													
Identification of number of operational & support personnel, facilities & organizational, intermediate & depot support elements that must be in place to support IOC & FOC determined as early in development process as possible but not later than MS III.	P			S	P												
SOFTWARE DESIGN AND DEVELOPMENT																	
Use of Ada programming language for vehicle subsystems & LRU's that use microprocessors.	P			S													
Non–proprietary S/W documentation & source code shall be developed & delivered.	P																
Delivery of all S/W support tools & associated documentation necessary to maintain & upgrade S/W after system is deployed is rqd.	P																

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